ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXVIII., No. 21.

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THE NEW ORLEANS DRAINAGE WORK is practically inaugurated this week by work commenced on the great central plant, by the National Construction Co. Test piles, 60 ft. long, are being driven to ascertain the nature of the soil beneath, as the entire structure must be carried on piles. The machinery is all under contract and will be completed by the time it is needed.

THE CHICAGO DRAINAGE CANAL has had a change made in the route below the regulating works which will control the flow of the water from the canal to the Des Plaines river. Plans had been made and bids received for a tail race and weir dam on what is known as the west route, with provision for utilizing the water power. Owing to the high rates at which the owners held the property through which a right of way had to be secured, the Trustees of the Sanitary District, on Nov. 10, decided to abandon this route and construct the work along the central route. It is estimated that this will effect a saving of about $350,000, as well as a considerable saving in time, the central route being shorter than the west route.

THE CHICAGO RIVER is to have its capacity increased by means of by-pass channels so as to give the flow of 300,000 cu. ft. per minute required by the drainage canal. An agreement has been arrived at between the Pennsylvania lines and the Trustees of the Sanitary District for the construction of a by-pass under the railway tracks along the narrow portion of the river between Adams and Van Buren Sts.

NEW BIDS FOR GARBAGE COLLECTION AND DISposal at Chicago will be received by Commissioner of Public Works, Mr. L. E. McGann, until Nov. 20, the various bids noted last week having been rejected. It is reported that the new specifications will be like the old ones, except that bidders will not be required to state the system of final disposal to be employed by them.

A COMMITTEE ON BUILDINGS has been appointed by the Mayor of Chicago to inspect and approve all plans for buildings before a permit is issued for construction, as formerly these permits have been issued without sufficient examination of the plans submitted. The committee is composed of the following members, representing various interests: Joseph Downey, Builders' and Traders' Club; J. Lewis Cochran, Real Estate Board; Harris W. Huehl, architect; E. S. Shankland, Western Society of Engineers; Thomas A. Bowden, Board of Underwriters; George Tapper, Builders' and Traders' Exchange; and Aldermen Kimbell, O'Malley and Sproul.

THE SPECIFICATIONS FOR A NEW WATER SUPply for Jersey City have been vetoed by Mayor Hoos. The specifications, as outlined in our issue of Sept. 30, 1897, provided for bids on three plans: (A) and (B) a gravity supply delivered at heads of 210 and 127 ft., respectively; (C) the filtration of water from the Passaic River. The Mayor recommends that bids be received on Plan A, only, which would entirely obviate the necessity of pumping or filtration. This plan calls for a daily supply of 50,000,000 gallons. The Mayor suggests a number of amendments to Plan A, which relate but little, if at all, to the strictly engineering features of the specifications. Regarding these features, he says.

Desiring the opinion of an eminent engineer, whose attitude would be that of a critic, I submitted the specifications to Mr. J. James R. Croes. While he made several suggestions of change in detail, I am pleased to convey to you his opinion that "the area of watershed required, the amount of storage necessary to be provided, the character of the materials and the workmanship demanded are all very fully and explicitly set forth in the specifications, which, on careful examination, appear to be framed with great care, and in accord with the latest experience and information in engineering practice."

UNBALANCED BIDS IN JERSEY CITY have been receiving attention of late. To prevent them a second new method of bidding for contracts for public work was recently introduced. Under this method unit costs of the various items making up the proposed work are estimated by the engineer of the Street and Water Board, and the bidder must state for what percentages of all of these items he will do the work, bidding above or below 100%, according to his wishes. This is intended as an improvement on the method noted in our issue of Sept. 23, 1897, under which the engineer made maximum and minimum estimates, and all bids were rejected that did not come within these limits.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head-end collision between a Chicago & Eastern Illinois passenger train and a Wabash milk train at Hammond Junction, in the outskirts of Chicago, Nov. 10. The accident was due to a misplaced switch, and resulted in the injury of five persons and the probable death of the engineer of the Chicago & Eastern Illinois train.

A BRIDGE ACCIDENT which might have had serious results occurred last week at the South Halsted St. vertical lift bridge. An electric car approached the bridge just as the bridge was to be raised, and the rising floor lifted the front end of the car about 4 ft., the car then dropping back on the track. Several passengers were bruised and cut by broken glass. A few weeks ago the bridge was raised just as a peddler's cart was going off. The cart was thrown into the river and two men were drowned. This bridge, like most of the Chicago River drawbridges, has no gates, and there is no proper system of communication between the engineman and watchmen on the approaches.

A RAILWAY DRAWBRIDGE ACCIDENT occurred Nov. 10 at Chicago, by which one man was killed. A switch engine of the Chicago & Northwestern Ry. had just backed a train of empty cars into the Wells St. terminal station and was returning to the yards on the west side of the river when it ran into the open draw. The engineman did not notice the red lights and the signalman shouted to him to stop, and as he turned back to ask the signalman what he said the engine went down. The engineman escaped by climbing out of the window of the cab, but the fireman was drowned. The accident happened about 5.30 p. m., which is before the time for opening the bridge for the passage of boats, but the bridge had been opened for a government tug, as these boats must be allowed to pass at any time. It is thought that the engineman must have been careless in looking out for signals, knowing that it was not the time for the bridge to be opened.

TRACK ELEVATION AT CHICAGO has at last extended to the St. Charles Air Line, the four railways owning which have been disputing over the matter for about three years. This means the abolition of the complicated and dangerous crossing at Clark and 16th Sts., where four or five electric railways cross a network of tracks in constant use by trains and switch engines. The work will, it is stated, be commenced next spring.

THE COLUMBIAN EXHIBITION OF 1893 is recalled to mind by a decision of Judge Grosscup, at Chicago, in a suit brought by the French government and French exhibitors against the World's Columbian Exposition Co. for damages caused by the fire at the exhibition on Jan. 8, 1894. The amount of the claim is about $75,000, and the loss to the government included some rare and costly tapestries and magnificent Sevres vases made specially for the entrance to the chamber of deputies. The fire started in the Casino and spread to the Peristyle, and sparks then set fire to the wooden walls on the roof of the Manufacturers' Building, and the burning timbers fell into the building setting fire to the exhibits. Until the close of the exhibition a stand-pipe supplied with water from the Worthington pumps furnished fire protection for the roof of this great building, but when the pumps were removed no equivalent means of protection was provided, and the court holds that this should have been done by the company as a means of fireproofing rather than fire protection, since these walls were the only exposed inflammable part of the buildings and if they could have been wetted the building would probably not have caught fire. The court also holds that the responsibility of the company did not end with the closing of the exhibition, that special precautions are expected from the custodians of such valuable exhibits, that the company's arrangements delayed the exhibitors in packing their exhibits and removing them from the building, and that the company is the particular branch or agency of the exhibition upon which was charged the duty of maintaining the fireproofing arrangements. The final conclusion is that the company was guilty of negligence in permitting the fireproofing arrangements to lapse, and that this negligence is the immediate cause of the injury from which the plaintiffs have suffered.

AN ELECTRICAL EXHIBITION will be held in Turin, Italy, next year, from April to October inclusive, in connection with an exhibition to celebrate the 50th anniversary of the proclamation of the Italian Constitution. Foreign manufacturers are invited to exhibit.

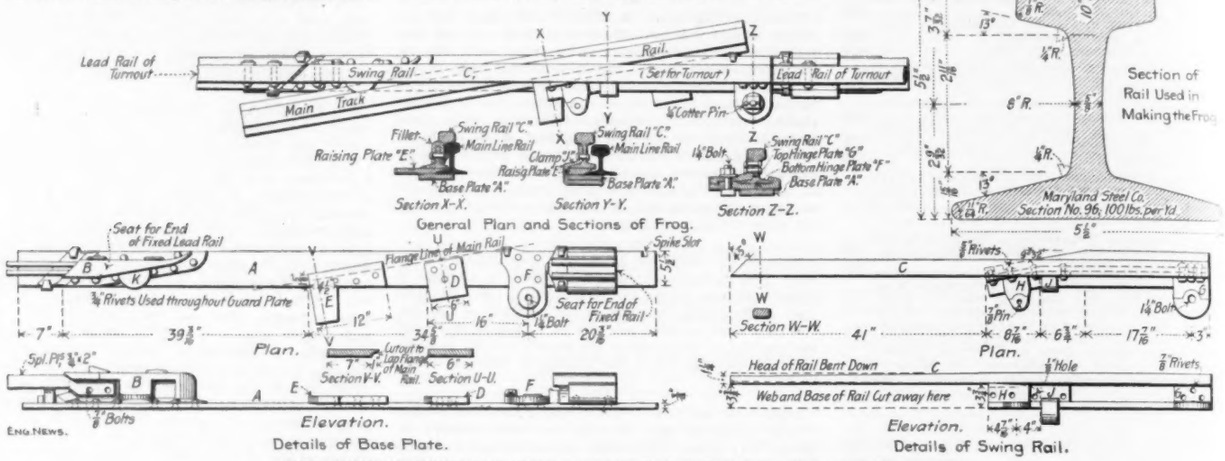
AN ELECTRICAL TRANSMISSION PLANT has recently been completed by the Blue Lake Water Co. in Alpine and Amador counties, Cal. Ten small lakes between 4,000 and 8,000 ft. above the power station, with a catchment area of about 67 sq miles form the source of water supply. By damming their outlets a total storage capacity of 20,942,000,000 gallons was secured. These lakes discharge into the Mokelumne River, and at a point about 45 miles from the lakes the water of this stream is diverted into the Amador Canal. This is an artificial channel 42½ miles in length, made through very rugged country. There is one tunnel and 82 flumes, aggregating 3.7 miles in length. The canal has a grade of about 8 ft. per mile, which gives a velocity of 300 ft. per minute, and a capacity of 3,000 miners inches. The ditch ends in a concrete forebay and settling basin, which also forms the upper end of the pipe line. This conveys the water a distance of 3,240 ft. to the turbines, with a drop to the point of delivery of 1,242 ft. The pipe is in five sections, which vary in diameter from 48 ins. at the upper end to 15 ins. at the turbines. Where flange joints were made ⅛-in. sheet lead gaskets were used as packing, and these were compressed by drawing up the flange bolts until only 1-9-in. thick. In a test of sections of 15-in. pipe joined in this way a pressure of 1,200 lbs. per sq. in. was withstood. To anchor the pipe and prevent mechanical injury the entire length was sunk to the surface of bed rock, and the last 400 ft. was embedded in concrete in a trench blasted out of the solid rock. Three 700-HP. Doble water wheels, 4 ft. in diameter, with a working speed of 600 revolutions per minute, are directly connected to three Stanley two-phase inductor generators. The power generators give 7,200 alternations per minute, with a voltage which can be regulated from 2,000 to 2,400. An interesting feature is the entire absence of any sort of receiver or air chamber. Notwithstanding the great pressure employed, nearly 500 lbs. per sq. in., the only protection at present against water hammer, is a form of gate which cannot be closed rapidly.

THREE-PHASE CURRENT transmitted from the water power plants of Sacramento and San Jauquin Rivers is being used to operate milling machinery in Fresno, Cal. In the case of the Sperry Flour Mill a 150-K-W. General Electric synchronous motor, running at 600 revolutions per minute, is operating the various machines. In another mill, which is the largest flour mill in the United States using electricity as a motive power, three General Electric three-phase induction motors, of 75, 30 and 20 HP. are belted to the mills, cleaners, etc. These motors are provided with recording meters and are run only when the machines to which they are connected are needed, thus effecting a saving of about 15% in power.

SOME RAPID ELECTRIC RAILWAY CONSTRUCTION was recently accomplished near Bound Brook, N. J., where 2½ miles of road was constructed in 22 hours, including all grading and overhead line construction, by the New York & Philadelphia Traction Co., in an effort to outwit a rival company and prevent the stopping of work by an injunction. The right of way between Bound Brook and Somerville was being disputed by the New York & Philadelphia Co. and the New Brunswick Traction Co. The former quietly arranged with J. G. White & Co., of New York, to build the section during the 24 hours between 12 o'clock Saturday and 12 o'clock Sunday nights. The work required the transportation of 600 men, four cars of tools and provisions, large quantities of poles and ties, lighting apparatus, tents, etc. The work was accomplished, current turned on from a temporary power station built on the property of an interested party, and a car run over the line within the allotted time, notwithstanding the opposition of the local authorities, who were obliged to succumb to the superior numbers of their opponents. While the feat is a remarkable one from an engineering point of view, we believe that corporations which override laws in such a manner establish most dangerous precedents, and should be allowed to reap no benefit from their high-handed work. Street railway companies who take possession by force of the public streets will deserve no protection from the public officials when their property is endangered by strikes.

THE COUGHLIN SWING-RAIL FROG.

A feature of railway track which has always been regarded as an objectionable feature is the necessity of breaking the continuity of the rail at every frog, and though of late years the force of this objection has been considerably reduced by the general use of spring-rail frogs, yet attempts continue to be made to devise some form of apparatus which will leave the main track rail absolutely unbroken and will also give a continuous rail to the side track, while at the same time the movable parts will be used only by trains on the side track. It is evident that if the main track rail is left absolutely unbroken, the turnout rail must be carried over it. Also, if the turnout rail is to be continuous, it must have a movable section which will rest on the main track rail when the switch and frog are set for the turnout, but will be moved so as not to foul the main rail when the switch and frog are set for the main line.



THE COUGHLIN SWING-RAIL FROG; Coughlin-Sanford Switch Co., Makers, Baltimore, Md.

These are the essential features of the Coughlin "swing-rail" frog here described. The principal parts of this frog are the base plate and the swing-rail, the former supporting the ends of the fixed lead rails and also supporting the unbroken main track rail while on it is the hinge of the swing-rail, this latter being the movable part of the lead connecting the ends of the fixed lead rails. The base plate (A) is 8 ft. 5 ins. long, 5½ ins. wide and ¾-in. thick. Riveted to it is the seat (B) on which the tongue of the swing rail (C) rests when the switch is set for the turnout. The end of the fixed lead rail rests on this seat, which gives it the proper elevation to engage with the swing rail, the end of this fixed rail being held by two hook-shaped clamps on the seat, which hold the edges of the rail base. It will be seen that the ends of the rail and seat are cut to form a miter joint, while the lead rail is securely attached to the seat of the base plate by a pair of flat splice bars ¾ × 2 ins. The raising plates (D) and (E) bring the swing-rail to its proper elevation. At one end is the hinge plate (F), shown also in the cross section Z-Z, and beyond this is a seat for the end of the other fixed lead rail abutting against the heel of the swing tail, the seat having two grooved shoulders or clamps which hold this rail firmly on the base plate of the frog.

The swing-rail (C) is made from a piece of 100-lb. rail, 6 ft. 4⅝ ins. long, planed to the shape shown, and fitted with a hinge plate (G) and the clip (H). This clip is attached to a U-shaped fillet which fits over the web of the rail, as shown in the cross-section X-X, and forms a support for the tongue over that portion of the web and flange which is cut away from the head and bent out to the desired angle. An ordinary switch rod is connected to this clip and to a bell-crank operated by a rod from the switch. The swing-rail is also fitted with the guide clamp (J) shown in cross-section Y-Y, which serves to hold the rail firmly down upon the base plate when set for the lead. The thickness of that portion of the tongue which rests directly on the main track rail is 1¾ ins.

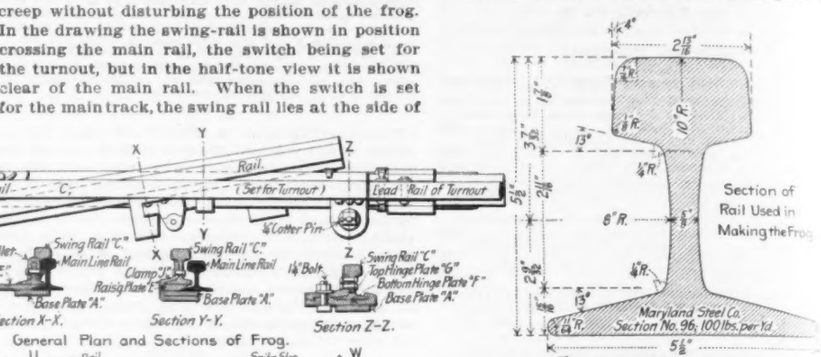
The main line rail is clamped to the base plate by the projecting rib (K) on the seat (B), and also by the raising plate (E), this latter being made to lap over the flange of the rail, as shown by the cross-section V-V and Y-Y. This arrangement holds the main rail in line, but allows it to creep without disturbing the position of the frog. In the drawing the swing-rail is shown in position crossing the main rail, the switch being set for the turnout, but in the half-tone view it is shown clear of the main rail. When the switch is set for the main track, the swing rail lies at the side of and parallel with the main track rail, leaving an ample flangeway, and the frog is thus not subjected to wear or strain by trains on the main track.

The first swing rail frog of this pattern was put in place on the Western Maryland R. R., April 2, 1896, and there are now 16 of these frogs in use on the Lehigh Valley R. R., Western Maryland R. R., Chicago & Eastern Illinois R. R. and the Pennsylvania Lines, the first two lines having given them the most thorough trial. All but one of these are on main line turnouts where the traffic is heavy. The frogs are made by contract for the Coughlin-Sandford Switch Co., Equitable Building, Baltimore, Md., and we are indebted to that company for blue prints and particulars of the frog.

Since preparing the description of the frog we have received a letter regarding it from Mr. C. O. Vandevanter, M. Am. Soc. C. E., Principal Assistant Engineer of the Western Maryland R. R., together with some photographs, and we print his letter as follows:

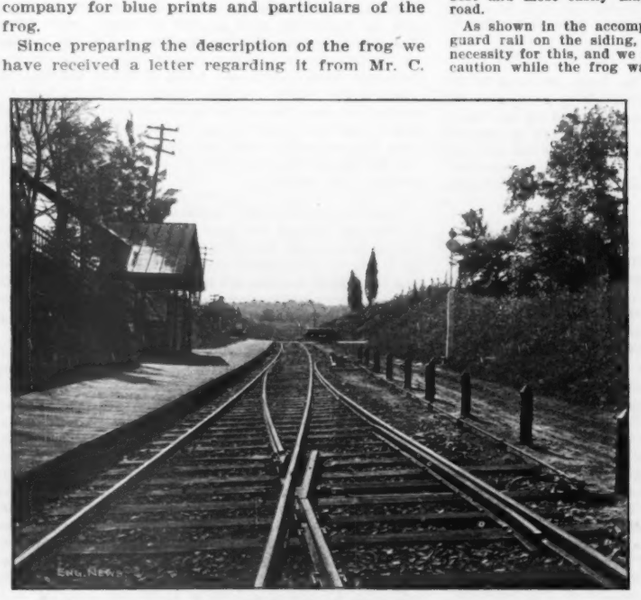
Sir: I enclose herewith photographs showing a patent frog we have had in our track for the past 18 months. As you will see, this frog gives an unbroken main line, carrying the rail of siding over that of the main line, thus giving some elevation to the outside rail of the turnout curve.

The strong point in this frog, and where it differs from those I have seen, where an unbroken rail was maintained, is the heavy base plate extending under the entire length of the frog, thus holding the parts firmly together. The tongue or movable part is made from a 100-lb. steel rail with the base and web partially cut away so as to allow it to pass over the top of the main line rail, forming a bridge to carry the wheels when the frog is set for the siding. When in this position the tongue is securely locked against side or vertical motion.



The frog is substantially made throughout, and as it is only used by trains taking the siding, its life, at unimportant points, would seem to be the time required to rust out, while at the most used points its life would be greatly lengthened over either the stiff or spring-rail frog, besides getting rid of the wear on rolling stock caused by the pound in passing the ordinary frog. While we may not be able to determine how much this is it is certainly considerable. If we can eliminate the frog from our main line track we shall have got rid of one of its most expensive features to both rolling stock and maintenance of way, and a constant source of danger and annoyance, and in its place shall have what should be the best and most easily maintained piece of track on the road.

As shown in the accompanying photographs there is a guard rail on the siding, but I very much question the necessity for this, and we only adopted it as an extra precaution while the frog was under trial. We placed our first frog at the opening of one of our yards in Baltimore, in April, 1896, where it has been in constant use ever since, and has given perfect satisfaction in every respect.



VIEW OF COUGHLIN SWING-RAIL FROG SET FOR MAIN TRACK.
Western Maryland R. R.

As the frog and switch-points are thrown by the same lever, and we make flying switches at this point every day, we were fearful that trainmen might throw them as soon as a car passed the points, and before the preceding one had passed the frog, but so far we have not had a single instance of this.

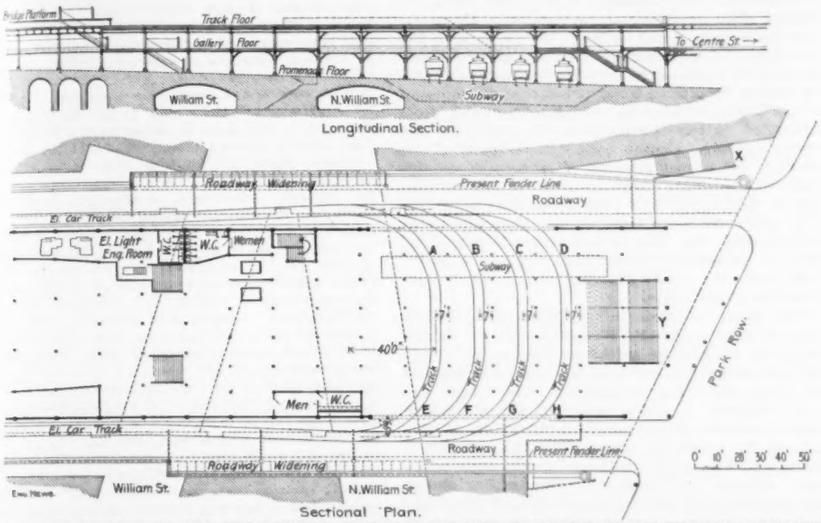
To test the effect of a train passing through on main line when the frog was set for the siding, we ran an engine through. As there was no weight on the tongue of the frog, the wheel simply pushed it out of the way, and in doing so threw the lever that operates the switch, thus setting it also in proper position. To facilitate this, we make no provision for locking the lever when set for the siding, so that there is nothing to prevent its being thrown for main line by the engine. We attached a tripping-bar to the first frog we put in that would clear the track before the engine reached the frog, but having satisfied ourselves that it was entirely unnecessary, we have left it off the six we have put in since.

The frog shown herewith is operated in connection with a Wharton switch, but it works equally as well with the Lorenz switch. Three out of the seven on our line are connected to Lorenz, and four to Wharton switches.

I feel from our experience with this frog that it is worthy of the serious consideration and careful investigation of all persons interested in the improvement of our tracks, and the lessening of the expense of maintenance of way of our railways.

THE PLANS FOR RUNNING THROUGH CARS OVER THE BROOKLYN BRIDGE.

As most of our readers know, arrangements were completed some time ago (Eng. News, Aug. 26, 1897,) by which the surface and elevated railways of Brooklyn, N. Y., will run their cars across the Brooklyn Bridge without a break in their journey and for a single fare. Although the general idea of through cars had been suggested some time previous, the first definite action was taken in the winter of 1896-7, when a commission of experts was appointed to report upon the feasibility of such an arrangement, and to suggest plans for carrying it out. This commission reported in favor of the scheme and presented very full plans for doing the work, which were published in our issue of Feb. 18, 1897. In the experts' plans for the New York terminal, as will be seen from these drawings, the elevated railway platforms occupied the center portion of the station, and the surface railway platforms were placed at each side of the center at about the same level. A series of loop tracks connected the two sets of surface railway platforms, these loops passing outside of the building on an elevated structure at the extreme end and around the tail switches of the elevated railway tracks.



PLAN AND SECTION OF NEW YORK TERMINAL STATION OF THE BROOKLYN BRIDGE SHOWING PROPOSED ARRANGEMENT OF SURFACE ELECTRIC RAILWAY TRACKS.

Shortly after receiving this report, the trustees of the Brooklyn Bridge entered into negotiations with the various surface and elevated railway companies with the view of having these plans carried out. After a great deal of discussion the railway companies agreed to the plan in its general features, but with one important modification of detail. This modification provided that the surface cars should pass onto a level directly above the elevated railway tracks at one side of the building, cross the building by three concentric loop tracks with platforms on each side, and pass out of the building on the side opposite to that on which they entered.

By this construction the elevated and surface railway platforms would be at different levels, the surface railway platforms being above the elevated railway platforms and about 50 ft. high above the street. A system of six elevators would give communication between the street and elevated railway levels and the surface railway platforms.. Four of these elevators would have a capacity of 12,500 passengers per hour each, and were to run from the street to the surface railway level only. One of the other elevators was to connect the elevated and surface railway platform levels, and the second was to connect the surface railway platforms and the present gallery level just below the elevated railway platforms. During rush hours it was proposed to run the four main elevators loaded one way only, as at these hours the movement of passengers is practically all one way. Thus, in the morning, when the movement is from Brooklyn toward New York, the elevators would descend loaded and ascend empty, and in the evening the opposite would be the case.

The contracts, which were signed Aug. 23, provided that work on the surface railway terminals should begin within ten days, and be completed within six months. The Brooklyn Elevated Ry. was required to begin work within 60 days, and have it completed in six months, and the Kings Co. Elevated Ry. had one year in which to complete its work.

Previous to the signing of the contracts the plans had not come into the hands of the engineers of the bridge, but immediately afterward they were handed over to the engineers to be carried out according to the contracts with the railway companies. As soon as they received charge of the plans, the bridge engineers raised objections to the method adopted for handling the surface railway cars at the New York terminal, and submitted other plans which provided that these cars should enter and leave the terminal at the street level. This modification was accepted by the Bridge Trustees and by the surface railway companies, and new contracts were made and the work of construction begun.

The accompanying plans show the final arrangement adopted for handling the surface cars at the New York terminal. The plan for handling the elevated railway cars was not changed except in minor details from the original plan of the experts, published in our issue of Feb. 18, 1897. The surface cars cross the bridge toward New York on the right hand roadway and enter the New York station on the loop tracks, stopping at E, F, G or H to discharge their passengers. When unloaded the cars cross the station to the points A, B, C or D, and stop to receive the passengers for the return trip to Brooklyn. When loaded the cars pass out of the station onto the opposite roadway and proceed on their way toward Brooklyn. The movement of the cars on the bridge, and particularly in the bridge terminal, is under the control and regulation of the bridge policemen. Persons not wishing to use the surface cars ascend to the track level of the bridge cars and elevated railway cars by means of the stairways X or Y, without crossing the trolley car tracks. It is also planned, should it be found necessary, to build a subway underneath the surface car tracks, but this subway is not intended to be built unless it is absolutely necessary, although the plans and the contracts with the surface railways call for its construction at the discretion of the Bridge Trustees.

It will be seen from what has been said, that the only persons using the bridge who will have to cross the surface tracks are the surface car passengers and the few pedestrians to and from the bridge promenade. These latter, it may be stated, form a very inconsiderable part of the total number of people crossing the bridge. All of these people, it is considered, can be safely handled by the bridge policemen without danger, since the routes of the incoming and outgoing passengers are entirely distinct, and the motion of the cars anywhere within the station will be extremely slow. In case it should be desirable, it is at any time possible to control this movement of the people and cars further by constructing gates to shut off the trolley tracks from travel in either direction, that is, either to or from the station.

In conclusion it may be noted that a temporary injunction has been secured restraining the Bridge Trustees from constructing the surface loop tracks as projected, and calling upon them to show reason why the subway should not be built under the tracks or some other construction adopted to do away entirely with the necessity of people crossing the tracks at grade. The testimony in this injunction suit is now being heard by the courts.

NOTES ON THE SPEED TRIALS AND EXPERIENCE IN COMMISSION OF OUR NEW BATTLESHIPS.*

By Philip Hichborn.†

Owing to various circumstances, which I will not discuss, the trials to which the new battleships of our navy have been subjected, while amply sufficient to demonstrate their compliance with contract requirements and their value as vessels of war, have not been so extended or in such detail as would be desirable from the point of view of the naval architect; and hence what I have to say can only be regarded as notes, owing to the absence of full data. The four battleships referred to are the "Indiana," "Massachusetts," "Oregon," and "Iowa." The first three named are of the same class, and the first two being by the same builder are practicall identical. The "Oregon" has various minor differences and departures from her sisters which are the natural result of her construction by a different firm, the most marked difference being the use of hydraulic power for turning the heavy turrets and steering the ship, while steam is used directly for these purposes on the "Indiana" and "Massachusetts." The table below gives the dates of trial of the battleships, and the corresponding indicated horse-power, speed, mean draft, and displacement.

Vessel.	Date of trial.	Displacement, tons.	Mean draft, ft.	ins.	I. HP.	Speed knts.
"Indiana"	Oct. 18, '95	10,255	23	11	9,738	15.55
"Massachusetts"	Apr. 25, '98	10,265	23	11½	10,403	16.20
"Oregon"	May 14, '98	10,250	23	11	11,111	16.79
"Iowa"	Apr. 7, '98	11,340	24	..	12,105	17.09

The trials were all made over a long course, the four-hour run being made half in one direction and half in the other. Vessels anchored along the course observed the direction and force of the tidal currents, the effect of which was already partially eliminated owing to the fact that two runs were made—one with and one against the current. The indicated horse-power was observed with great accuracy, and, altogether, it may be said that the results are as accurate as it is possible to make them.

It may be said that the results of the trials of these vessels, as regards speed and power, compare very favorably with those of large battleships abroad, and indicate also that our battleships now building will give results, as regards speed, agreeing most satisfactorily with the estimates.

The "Iowa" is of somewhat different type from the "Indiana" class. It will appear from descriptions of the vessels given at former meetings of the Society that the "Iowa," while about 1,000 tons larger than the "Indiana" class, was designed to have slightly less gun power, slightly less thickness of protection, somewhat greater speed, greater freeboard forward, and a greater coal supply under normal conditions. As I shall explain later, the promises of her design have been fulfilled, with a good margin to spare, so that she can carry even more coal than originally contemplated, without increased displacement.

Both types of vessel have given good satisfaction in service, and experience with their strong or weak points will be very valuable in case of future battleships. It may be remarked, in passing, that our battleships now under construction are, in many of their features, a compromise between the "Iowa" and "Indiana" types, which are themselves not very widely dissimilar, so that our battleship fleet to date, built and building, while its members differ from one another, will have to a marked degree, except as to their batteries, that feature of homogeneity which all authorities recommend as desirable.

I believe that the predominant opinion among our naval officers who have had experience with these vessels is

*Abstract of paper read at the fifth annual meeting of the Society of Naval Architects and Marine Engineers, held in New York, Nov. 11 and 12, 1897.

† Chief Constructor United States Navy.

that a trial of speed of 16 knots is sufficient for our battleships under present conditions, and will not need to be materially increased until foreign battleships promise materially greater speeds than they now reach, and that the policy which the Navy Department has followed from the first with these battleships, namely, to give them offensive and defensive power sufficient to enable them to cope with those of any foreign country, without insisting on giving them the speed or carrying the amount of coal and supplies which the circumstances of various foreign navies render desirable, thus making our ships materially smaller and less costly than they would otherwise require to be, is correct.

I do not wish to be understood as stating that our battleships are perfect, or that in our experience with them so far there have not been troubles and difficulties and minor accidents of various kinds. It should be remembered, however, that these were the first battleships designed or built for our navy, and I do not hesitate to state that they are vessels concerning which no one who has any connection with them has cause to be ashamed. I may mention as perhaps the most serious accident which has occurred on any of these vessels, the breaking adrift of the unbalanced forward turret of the "Indiana" in a heavy gale about a year ago. The revolving weight of this turret is about 489 tons, and its center of gravity is about 3½ ft. from the axis of rotation. The conditions and circumstances are such as to call for the display, in the highest degree, of what the builder of the "Indiana" has characterized as "battleship seamanship," and I believe the difficulties on that occasion were grappled with and overcome promptly and fearlessly.

The behavior at sea of the "Indiana" class has been all that could be expected, from vessels of that type. Owing to their comparatively low freeboard, they are wet in heavy weather, but they have rarely encountered weather conditions sufficient to interfere with the manipulation of their guns. As a general rule, they have been remarkably steady, but as was to be expected, there are possible conditions at sea which make them roll heavily. They were originally designed to have bilge keels—the value of bilge keels to check heavy rolling being well known; but when it became evident that docks adequate to take in the vessels with bilge keels would not be completed as soon as the vessels, it became necessary to leave the bilge keels off. Experience at sea demonstrated, as was to be expected, the desirability of these appliances. They have already been fitted on the "Massachusetts," and will be fitted on the other vessels of the class at the earliest opportunity. The "Indiana" would have had them before this date but for the unfortunate breaking down of Dry-dock No. 3 at New York.

As illustrating the behavior of the "Massachusetts" at sea, I may quote from the report of her Commanding Officer, on a trip from Boston to St. Johns. During this trip the "Massachusetts" passed within 250 miles of the center of a cyclone, encountering a wind which reached the force of 10 on the Beaufort scale, and was accompanied by a heavy sea. The vessel slowed down during the height of the storm, and her Commanding Officer reports as follows:

> During this time the ship behaved beautifully, never making less than six knots per hour, nearly on her course, and never rolling over five degrees. Her steadiness was so remarkable during the whole passage that it must be, in a great measure, attributed to the bilge keels.

One feature of the "Indiana" class, as regards which they have been markedly successful, is their steering. Turning trials of the "Indiana," Feb. 24, 1896, showed a tactical diameter of but three times the length of the ship, an exceptionally small value. Her maneuvering qualities and steadiness on a course are all that could be expected from a short, broad, comparatively shallow vessel.

In concluding my few remarks, I should like to invite attention to a comparison between the weights of the battleship "Iowa," as estimated at the time of her design in 1892, and the actual finished weights obtained by weighing every object which went into the ship. The net finished weight of the ship, with her designed coal, at normal displacement, was within 20 tons of the original estimate—the total finished weight being 11,127½ tons, the estimate on the same quantity being 11,108 tons.

NOTES FROM THE ENGINEERING SCHOOLS.

Massachusetts Institute of Technology.—A number of changes have been made in the instructing staff. Arthur A. Noyes, S. B., Ph. D. (Leipsic), has been made associate professor of organic chemistry. Frank A. Laws, S. B. (M. I. T., '89), is now assistant professor of electrical measurements; Harry M. Goodwin, S. B. (M. I. T., '90), Ph. D., is now assistant professor of physics.

The following have been made instructors: Carl H. Clark, S. B. (M. I. T., '95), and Frederick A. Hannah, S. B. (M. I. T., '95), in mechanical engineering; Charles M. Spofford, S. B. (M. I. T., '93), in civil engineering.

In addition to these a number of assistants have been appointed, largely among the graduates of last June, taking the place of assistants who have left to engage in other work.

The growth in attendance at the Institute has necessitated a corresponding improvement in facilities and equipment. In the department of mining engineering the number of students is nearly doubled the present year, going from 40 to about 70. To provide for this extra number a new table with assaying desks has been put in, increasing the capacity of the assaying department by one-third. The weighing room has been provided with eight tables and eight new balances.

The crushing machinery has been readjusted to give increased capacity and convenience. In addition, two new jigs, a new vanning machine and a new canvas table have been constructed.

During the summer the triple expansion engine at the engineering laboratories has been overhauled. As originally built, there were two double shell receivers on the engine. These receivers were jacketed between the shells with full pressure boiler steam (150 lbs. pressure). They have been replaced by two Wainwright reheaters of special design, so constructed that the amount of jacketing surface in use can be varied from one-third to two-thirds, or to the whole of the entire surface. Engine tests will be made to see what is the proper amount of surface to use for best results. This opens up a line of experimenting in which but little has been done thus far. The reheaters were built by the Taunton Locomotive Mfg. Co. The jacket steam is taken inside of corrugated copper tubes 1½ ins. in diameter, and the working steam into a shell surrounding these tubes.

New York University.—The Engineering School has received from the Westinghouse Air Brake Company a complete set of air brakes for a tender and passenger and freight cars, including the air pump and other equipments. The school has also obtained a model showing the automatic electric overlap system of block signalling. It represents in miniature about 16 miles of single track and five miles of double track, with turnouts, sidings and switches. The model shows the absolute and permissive systems of blocking, the proper arrangement of signals, the position of frogs, switch rails and other appurtenances.

Columbia University, Washington, D. C.—Prof. Elmer S. Farwell has been appointed professor of mechanical engineering, in the place of Prof. Zopke, who resigned to accept the position of mechanical engineer in a large color works at Hoechst-on-Main, Germany.

University of Nebraska.—A course of lectures on municipal engineering problems is being delivered by Mr. Andrew Rosewater, M. Am. Soc. C. E., City Engineer of Omaha. The dates and titles of the lectures are as follows: Nov. 8, "City Surveys and Grade Systems;" Nov. 15, "Drainage and Sewerage of Cities;" Nov. 22, "Pavements and their Maintenance;" Nov. 29, "Water Supply and Fire Protection;" Dec. 6, "The Engineer as a Factor in Municipal Government."

TORPEDO-BOAT DESIGN AND THE NEW TORPEDO-BOATS OF THE UNITED STATES NAVY.*

(With two-page plate.)

By H. G. Gillmor.†

The torpedo as an offensive weapon made its appearance during the war of the rebellion from '60 to '65, and, by its achievements during that war, established itself as a factor to be considered in naval warfare. So many and so brilliant had been the successes which were achieved through its use in this war that it was almost immediately taken up by the maritime powers of Europe and became a recognized naval offensive weapon. The torpedo of that time was the spar-torpedo; which, being carried at the end of a spar 20 to 25 ft. long, capable of being rigged out and in and placed at various angles, could be brought in contact with the bottom of the enemy's vessel by a pulling boat or a steam-launch and discharged by means of an electrical connection. For success it was necessary to come alongside the enemy before discovery and disablement. The rapid-fire gun of small calibre and the search light were not then in existence, so that the task of the torpedo in the hands of fearless men was, on a dark or foggy night, less impossible than might be thought.

For some years the torpedo remained as it was at the close of the war—the weapon of the regular pulling boats and steam launches of the man-of-war. Boats which in time of peace did duty as the regular running boats of the ship were provided with apparatus for the use of the spar torpedo in time of war as a part of their equipment. Early in the seventies it was proposed to construct small special steam vessels, in which the lightness of draft, fineness of lines, and exceptionally large motive power would ensure a speed of from 15 to 18 knots, for use as torpedo-boats. A little before this the Whitehead torpedo had been introduced and was being experimented with by all the European Powers. It was destined to revolutionize ideas of torpedo warfare and make more necessary the construction of the special torpedo vessels then proposed.

It is in England, in the yards of Messrs. Thornycroft and Yarrow, that special torpedo-boat construction was begun, and it is there that the torpedo-boat has become the very high-speed vessel that we possess to-day. The rivalry which has existed in the first instance between these two builders, and later among an increasing number of builders, has had quite as much to do with the development of the present types of torpedo-boats as have considerations of their warlike purpose and efficiency as means of offense. We are to-day accustomed to hear torpedo-boats spoken of as "20-knotters," or "30-knotters," as if speed, regardless of size, cost, number of men involved, offensive power, etc., were the one consideration in such vessels; and there is no doubt that in the popular mind a 30-knot boat must be far superior to a 20-knot or a 24-knot boat, no matter what may be the relations existing between other qualities of the two boats.

Messrs. Thornycroft built, in 1873, at their yards in Chiswick, to the order of the Norwegian government, the first special torpedo-boat constructed. This vessel, which was subsequently named the "Rasp," was 57 ft. long, 7 ft. 6 ins. beam, with a displacement of about 7½ tons and a speed of about 15 knots. She was originally provided with an apparatus for the towing torpedo. France began, under the programme of January 20, 1875, the construction of torpedo-boats subject to the following limitations: Length, about 20 meters (75.6 ft.); hull of steel capable of resisting musket fire; maximum speed, 14 knots; sufficient coal for eight hours at full speed. Our own government, in 1876, ordered a large wooden launch the "Lightning" of the Herreshoff Manufacturing Co. She was 58 ft. long; and was fitted with spar-torpedoes, and made about 17.5 knots on trial. In 1877, the "Lightning," the first English torpedo boat, was delivered by Messrs. Thornycroft to the English government. She was 85 ft. long and 11 ft. beam, with a displacement of 27 tons and made 19 knots on trial. The same year, the Russian government had no less than 100 boats of a similar character under construction by different firms. These boats were 75 ft. long, 10 ft. beam, with a speed of 18 knots. Italy followed the next year with a vessel very much like the "Lightning." About the same time the first German torpedo-boat was constructed. It was rather larger than the English and Italian boats. By the end of 1878 the torpedo boat had a place in the navy lists of the European Powers.

About the time of the beginning of the construction of special torpedo-boats, the Whitehead torpedo had made such progress as to find some advocates for its use. From the uncertainties attending the action of the early automobile torpedo and the demonstrated efficiency of the spar-torpedo under the existing conditions, the latter was in many instances preferred to the former, and most of the early torpedo-boats were originally provided with spar-torpedoes and later fitted for the use of the automobile torpedoes. The introduction of the rapid-fire gun was the death-blow of the spar-torpedo and emphasized the necessity for high-speed torpedo vessels for use with the automobile torpedo. The torpedo itself, and the means for firing it, were rapidly improved. The growth and improvement in the torpedo-boat more than kept pace with its principal weapon.

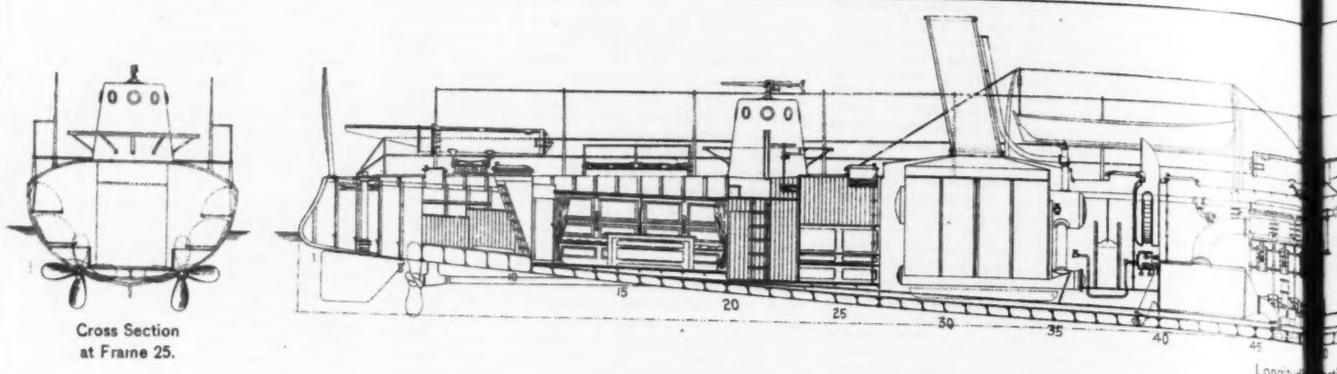
From 1878 on, the work of construction of special torpedo vessels by the European Powers has gone on steadily, although, in the case of individual nations, there have been delays from indecision as to the types which should be taken up. An enlargement in the sphere of the torpedo-boat, by which it was to prove its title to consideration as a separate branch of navies rather than one of the weapons of ships, was marked by the construction of sea-going torpedo-boats, of which the "Ratoum," completed in 1879 for Russia, was the first.

At the end of the year 1884, Russia possessed 115 torpedo boats; France, 50; Holland, 22; England, 19; Italy, 18; and Austria, 17. At the end of the year 1890, France possessed 210 torpedo-boats; England, 206; Italy, 152; Russia, 143; Germany, 125; Japan, 24; and Spain, 15. The "Cushing," the first United States torpedo boat, was that year commissioned.

That we, the nation which of all nations had had the largest practical experience with torpedoes in actual warfare, should have been the last to take up the torpedo-boat—which, after all, was but the logical application of our own war experiences to altered conditions and improved weapons—was doubtless due, in the first instance, to the attitude of Congress toward the navy, and its unwillingness to appropriate money for rebuilding and modernizing that important arm of the national defense, rather than to any lack of enterprise or foresight on the part of officers of the navy. When public sentiment changed and Congress turned its attention to the needs of

*A paper read at the fifth annual meeting of the Society of Naval Architects and Marine Engineers in New York, Nov. 11 and 12, 1897.

†Assistant Naval Constructor United States Navy, Washington, D. C.



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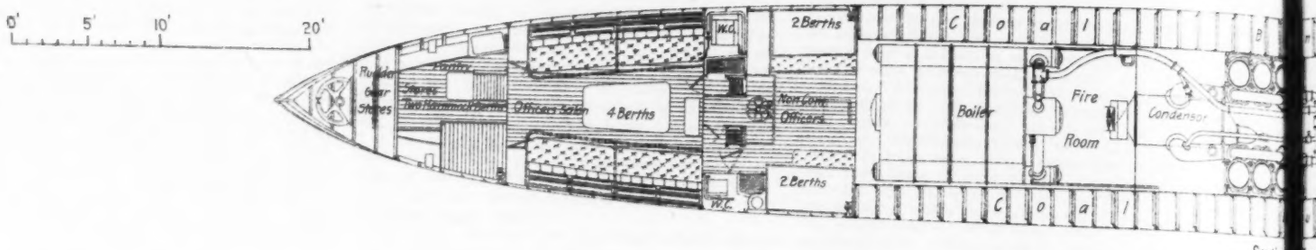

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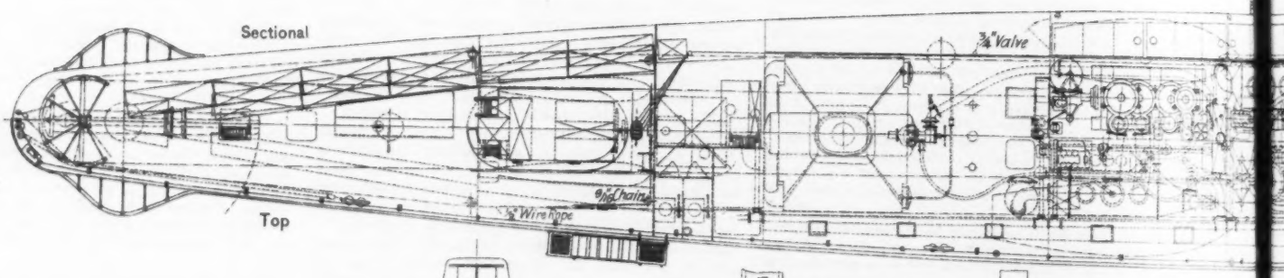
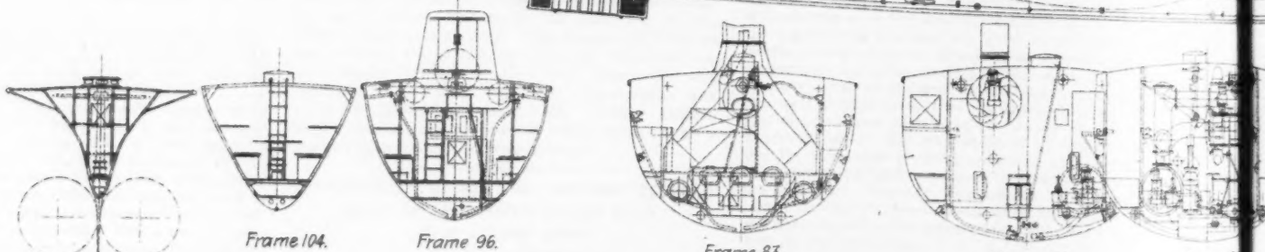
THE "DAVIS" AND "FOX," NOS. 12 A





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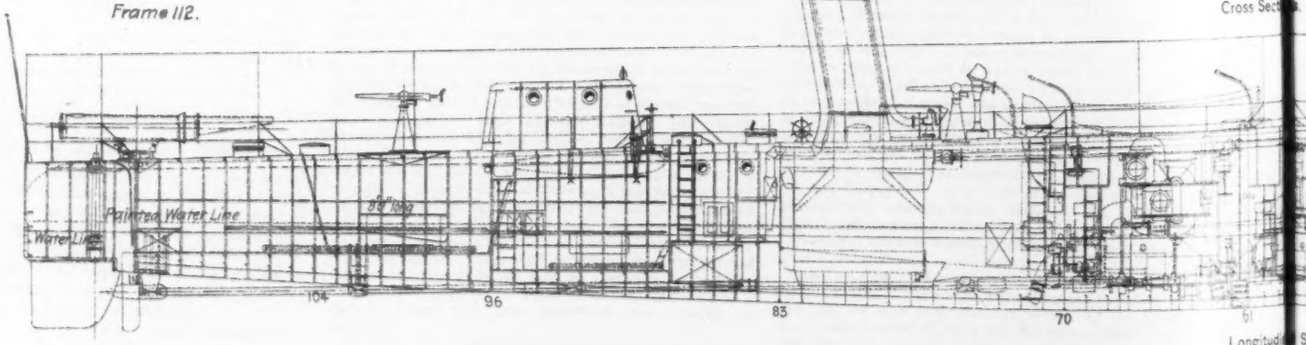

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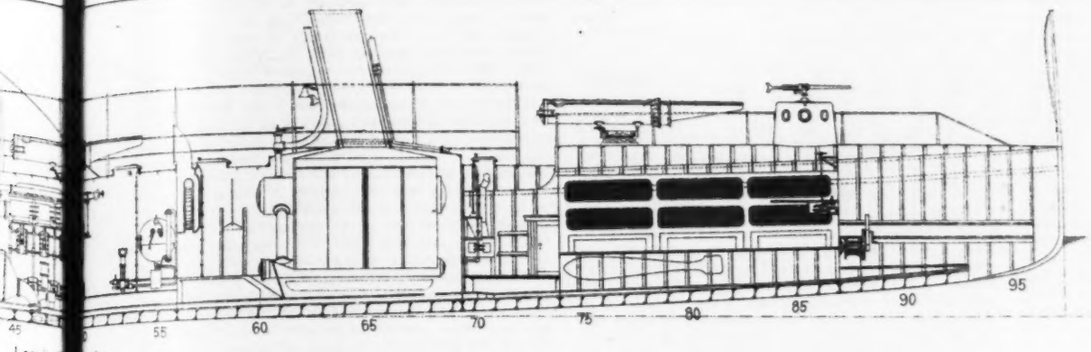
THE "PORTER" AND "DUPONT," NOS. 6 A

MODERN TORPEDO BOATS O



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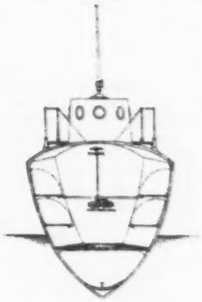
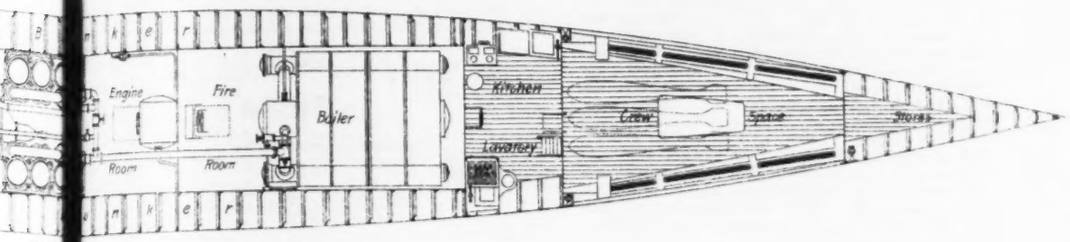


Cross Section at Frame 76.



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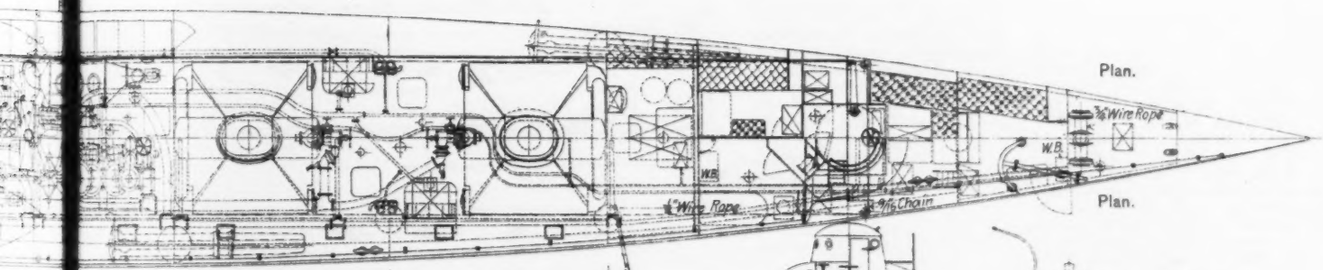
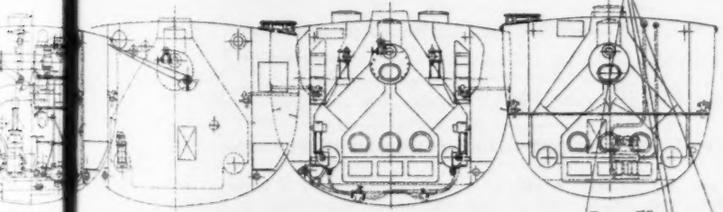
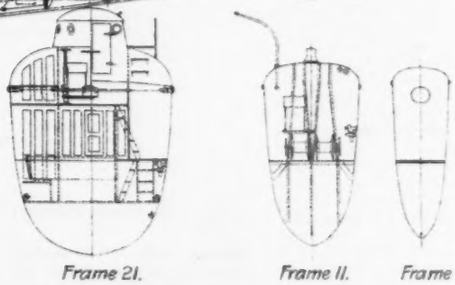
Cross Section of Torpedo Store Room.

NOS. 12 A 13; WOLFF & ZWICKER, BUILDERS.







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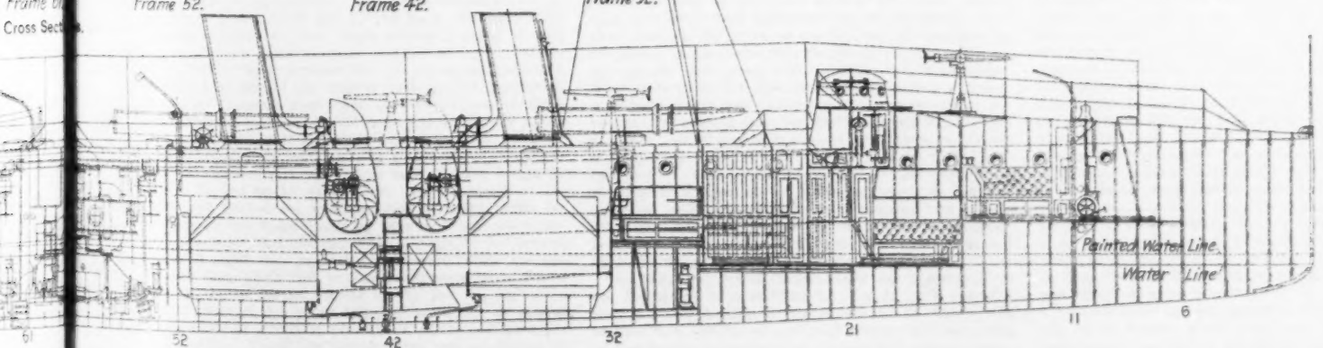

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NOS. 6 AND 7; HERRESHOFF MFG. CO., BUILDERS.

OATS OF THE UNITED STATES NAVY.

CHAS. HART & SONS, LITH., 99 VESEY ST., N. Y.

the Navy demands for the larger modern ships seem to have been so urgent as to have kept the torpedo-boat out of notice, although, just at that time, large expenditures were being made by the European Powers for this class of vessel.

From the time of the construction of the torpedo-launch "Lightning" in 1876, nothing was done toward providing torpedo-boats for the navy until 1888. That year the Navy Department purchased from the Herreshoff Manufacturing Co., a fast wooden yacht, the "Stiletto," 86 ft. 6 ins. long, 11 ft. beam, and about 31 tons displacement, with a speed of 18 knots. After some changes were made, this vessel was fitted as a torpedo-boat, for use in experimental work at the Torpedo Station in Newport, where she is still in service. The first modern torpedo-boat to be added to the navy was the "Cushing," built by the Herreshoff Manufacturing Co. for the Navy Department and commissioned in 1890. She was of galvanized steel throughout, and, at the time of her completion, was a good example of current practice. The same year, Torpedo-boat No. 2, the "Ericsson," was appropriated for.

It is in 1894 that the work of torpedo-boat construction seems to have been taken up in earnest. In July of that year, appropriation was made for three boats 160 ft. long and of 140 tons displacement, with a speed of 24.5 knots. The succeeding Congress made provision for three more of still larger size and higher speed. In June, 1896, Congress provided for the construction of three torpedo-boats

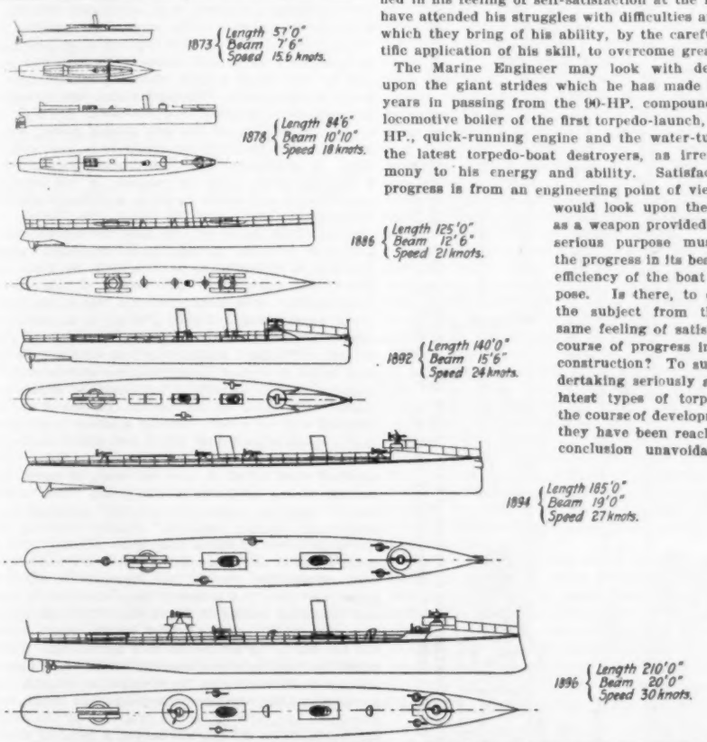
1873 Length 57'0" Beam 7'6" Speed 15.6 knots.
1878 Length 84'6" Beam 10'10" Speed 18 knots.
1886 Length 125'0" Beam 12'6" Speed 21 knots.
1892 Length 140'0" Beam 15'6" Speed 24 knots.
1894 Length 185'0" Beam 19'0" Speed 27 knots.
1896 Length 210'0" Beam 20'0" Speed 30 knots.

FIG. 1.—SKETCH PLANS SHOWING GRADUAL INCREASE IN SIZE OF ENGLISH TORPEDO BOATS SINCE 1873.

having a speed of 30 knots, and appropriated the sum of $500,000 for the construction of not more than ten torpedo-boats of lower speed. Under this second provision, contracts were entered into by the Navy Department for the construction of three boats having a speed of 22½ knots and four boats having a speed of 20 knots. Of the three 30-knot boats provided for, two are of small size and the third similar to the English torpedo-boat destroyers. The next Congress authorized the construction of three more 30-knot boats, all of the large size designated in the English service as torpedo-boat destroyers. In Table I. will be found such particulars as the names of the builders, dimensions, etc., as well as such data of design as are to be had for all these boats. An inspection of the table will disclose the wide variation in design which exists among the boats which we have built and are building. In order that the character of some of the several types included may be better understood, there are appended deck plans and profiles of Torpedo-Boats No. 6 and No. 7; No. 11; No. 12 and No. 13; and No. 14.

The limits of this paper forbid a description of any of these boats or a critical comparison of the several types represented. There are among them representatives of nearly all the types of the last few years, and in their use together in service, opportunities will be afforded for comparisons of their relative values which will be far more conclusive than could be a comparison in the abstract based upon the plans of the boats. Of the hundreds of foreign torpedo-boats built and building, there is not the space for a mention of even the most important.

At the end of the year 1896, the leading maritime powers possessed in serviceable condition, were building, or had projected torpedo-boats in the following numbers and sizes:

Lengths in feet.	England.	France.	Russia.	Italy.	Germany.	Japan.	Spain.	U. S.
Less than 100.....	64	28	80	21	..	4	12	1
100 to 125 inc.. ..	57	161	16	40	25	66	..	4
125 to 150 inc.. ..	39	62	105	119	107	35	28	7
150 to 180 inc.. ..	..	3	4	9	25	..	..	6
More than 180.. ..102	..	4	1	11	11	11	4	
Totals.. 262	254	224	181	168	116	56	22	

The figures illustrate the growth in a score of years of a branch of naval armament and the advance in ideas which has been made in that time as to the importance and utility of the torpedo-boat. In order that the extent of the change which has been worked in the torpedo-boat itself in the same period may be the more readily realized, boats of English construction of several of the years of this period have been arranged in Fig. 1, in the order in which they were produced.

The Naval Architect, surveying the achievements in torpedo-boat construction of the last two decades, is justified in his feeling of self-satisfaction at the results which have attended his struggles with difficulties and the proofs which they bring of his ability, by the careful and scientific application of his skill, to overcome great difficulties.

The Marine Engineer may look with deserved pride upon the giant strides which he has made in these few years in passing from the 90-HP. compound engine and locomotive boiler of the first torpedo-launch, to the 6,000-HP., quick-running engine and the water-tube boilers of the latest torpedo-boat destroyers, as irrefutable testimony to his energy and ability. Satisfactory as this progress is from an engineering point of view, those who would look upon the torpedo-boat as a weapon provided for a definite serious purpose must investigate the progress in its bearing upon the efficiency of the boat for that purpose. Is there, to one reviewing the subject from that side, the same feeling of satisfaction at the course of progress in torpedo-boat construction? To such a one, undertaking seriously a study of the latest types of torpedo-boats and the course of development by which they have been reached, is not the conclusion unavoidable that this development has been influenced by other considerations than those of the torpedo-boat as a weapon alone? Which of the types leading up to the present ones have ever been systematically and carefully tested after training the crews to the peculiar life required by the service to determine their fitness for the designed purpose or the lines along which changes should be made? What is there in the experiences of any nation with torpedo-boats which has demonstrated the necessity or advisability of passing from the first sea-going torpedo-boat of 100 ft. and 50 tons with a speed of 22 knots, to vessels of more than twice its length, four times its visible surface and six times its displacement, involving three times the number of lives and six times the cost of the smaller vessel in each engagement? And, assuming the desirability of the latest types for the nation originating them, is there anything in our own circumstances which makes advisable the acceptance of the same types by us?

The object for which torpedo-boats are constructed is the destruction of vessels of the enemy. It is intended that a vessel costing a few thousands of dollars and manned by a handful of men shall attempt the destruction of vessels costing hundreds of thousands of dollars, carrying hundreds of men. This is the prime object and mission of the torpedo-boat. One division of this special class may be called upon to attack torpedo-boats in order to protect the vessels of the fleet from injury by them.

The condition of equalization which comes in to give the immeasurably weaker unit a chance of success against the cruising ship is the secrecy of action possible under cover of darkness or fog. It is because this equalizing condition makes it possible that, at the risk of a few lives and the product of a few months of toil, the destruction of a vessel requiring many months to construct, costing hundreds of thousands of dollars and involving hundreds of lives, may be effected, that nations are willing to expend the money for, and individuals will risk their lives in attacks in, the torpedo-boat. For the secrecy of action and immunity from discovery upon which success is contingent, the torpedo-boat depends upon the visible surface which she presents—that is, upon her size. It is her small size which enables her to creep upon her antagonist and deal the deciding blow. Early discovery means to her failure always, and probable destruction. The protection of the torpedo-boat lies primarily in her size. In her secondary role of protector of the fleet against torpedo-boat attack, she is also dependent upon her size for success. To destroy, she must discover, and to discover the torpedo-boats making a stealthy approach it is necessary that the size and visible surface of the guarding boat should not be so greatly superior to that of the attacking boats that they may make her out in time to avoid her. The modern torpedo-boat destroyer, by its large size and attendant visibility, will, under the circumstances which are admitted as possible for torpedo-boat attack, defeat its own purpose. For success in any role within its province, it is imperative that the torpedo-boat should be of the smallest size consistent with the other necessary conditions. The advantages in number of men involved in each action, in first cost, and in handiness which accompany small size are so obvious that they need be only mentioned.

The purposes for which we require torpedo-boats naturally divide them into two large classes—the sea-going and the harbor or coast defense. This division, while not directly recognized in the classifications of torpedo-boats by the various nations, is accepted in the division of duties to which boats already constructed are considered assignable, and is implied in all the classifications. The characteristics of the boats for the two purposes are essentially as different as are the characteristics of the sea-going battleship and the coast-defense monitor. To obtain the best results the natural division should be recognized and boats designed and constructed to meet the requirements of service in each class.

The Sea-Going Torpedo-Boat.

It is imperative that the sea-going torpedo-boat shall be seaworthy—that is, capable of remaining safely at sea in all such weathers as may reasonably be anticipated. Since the size of the boat has so vital a bearing upon its efficiency, it is important to consider what limitations are placed upon size by the necessity of seaworthiness, in order that it may be determined whether the size of boat consistent with the other characteristics required is consisent with this demand. In 1879, the Russian torpedo-boat "Batoum" (length 100 ft., beam 12 ft. 6 ins., displacement 50 tons) made the voyage from London to Nikolaief, a distance of 4,800 miles, with a crew of three officers and nine men, at an average speed of 11 knots. In the following year, four boats for the Argentine Republic, of the same length and slightly less displacement, made the voyage from Plymouth to Buenos Ayres, under sail, with little difficulty, one of the boats requiring 72 days for the passage. Regarding the qualities of these boats, the captain who had charge of two of them in going out, wrote the builders, saying: "I have no hesitation in saying that their sea-going qualities are exceptional. On both voyages we encountered very rough weather, and in the case of the 'Brazilian' we were laid to off Cape Frio in a heavy S.S.W. gale of such a force as I have not experienced the like in twelve years, and she behaved admirably." In 1890, the English boats No. 61 and No. 62 (length 125 ft., beam 13 ft., displacement 75 tons), convoyed by the storeship "Tyne," made, under their own steam, the voyage from Plymouth across the North Atlantic, encountering severe gales, fog and icebergs. Since that time boats of about the same size have been sent by the English naval authorities under their own steam from England to their naval stations in Australia, Hong Kong, Singapore, India, and the Mediterranean. Boats for Japan, China, and South American states have made the voyages from the European yards at which they were built to the ports of the countries to which they belong. During the Japan-China war, sixteen of the Japanese torpedo-boats operated continuously, both independently and in conjunction with the fleets as was required, and did efficient continuous service, under war conditions, during the months from August, 1894, to April, 1895. From the most reliable information obtainable, these boats were, with the exception of the "Kotaka," 120 ft. long by 13 ft. beam, with a displacement of about 75 tons. These and other examples which might be cited prove beyond a peradventure the possibility of constructing boats of 100 ft. or longer, which shall not only be capable of remaining at sea in all weathers, but which shall, more than than that, be capable of making voyages of long distance at fairly constant cruising speeds.

Much is heard of the hardships of the crews of sea-going torpedo-boats and of the impossibility of their long sustaining the fatigue, etc., of the life. The remedy for this must lie in special training of men for this service. So long as the torpedo-boat is seaworthy, there can be no

question of the possibility of men living safely and comfortably on board, when once they have become accustomed to the life. It is to be expected that men whose service has been in ships of large displacement or in torpedo-boats in sheltered waters should be incapacitated when first they encounter unusually rough weather in torpedo-boats. The State of Massachusetts alone sends out more than 40,000 men who spend a large portion of each year at sea in fishing vessels, the average displacement of which is less than 50 tons, whaling vessels and steam trawlers being included in making up the average. No one who has seen the usual fishing vessel and who knows the provisions made for the crew of a torpedo-boat can say that, for men habituated to life at sea in a small vessel, the lot of the torpedo-boat crew is less happy than that of the crew of the deep-sea fishing vessel.

The size of the sea-going torpedo-boat may then be fixed by the considerations as to the qualities which it is desirable to embody in its design, with the certainty that, due regard being had for stability, it may be made seaworthy and habitable so long as the vessel determined by these considerations is not less than 100 ft. in length and 50 tons displacement. What are these qualities, what values do our needs assign to each, and what manner of boat is it to which a rational consideration of these will lead us?

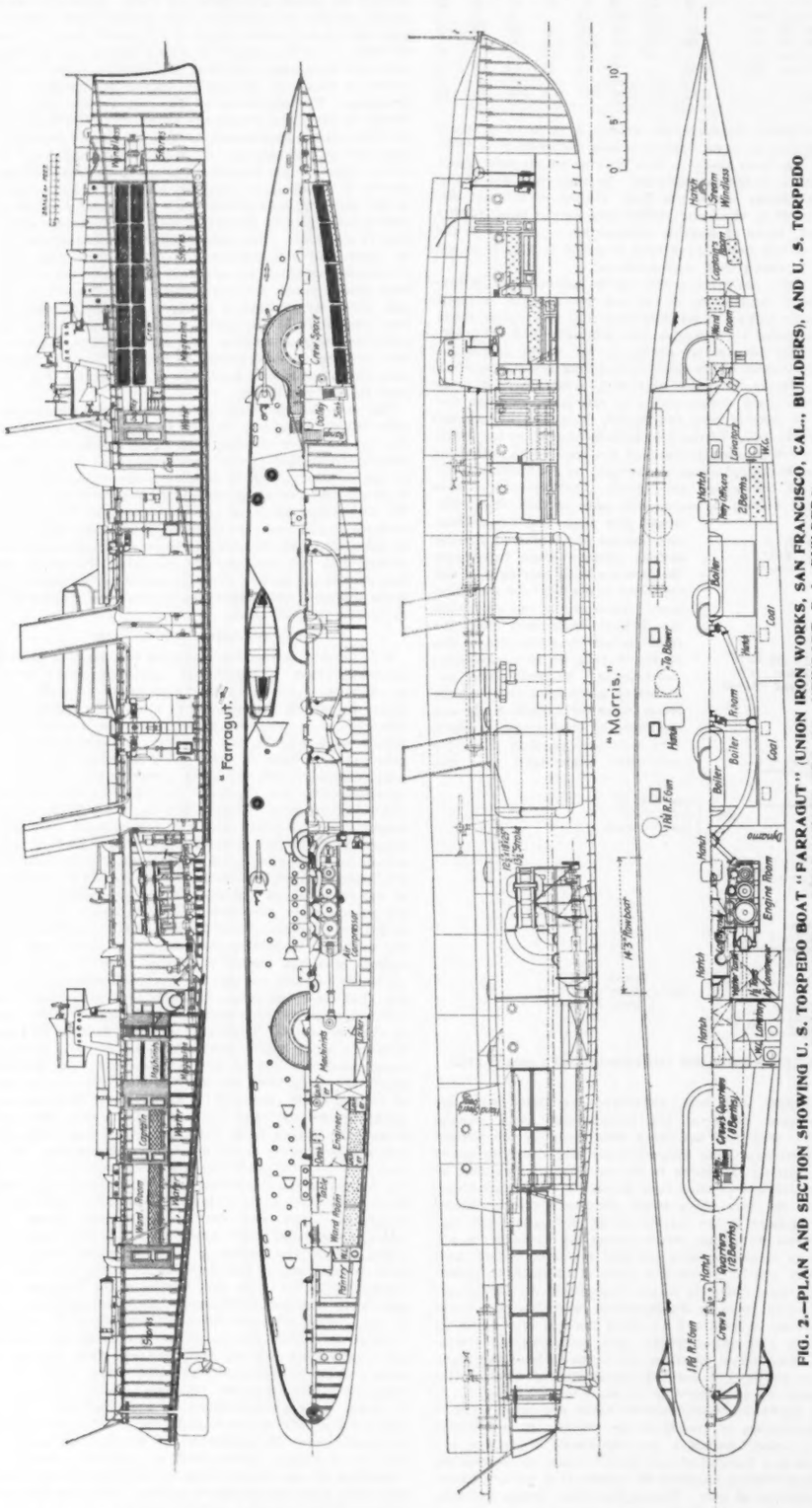

FIG. 2.—PLAN AND SECTION SHOWING U. S. TORPEDO BOAT "FARRAGUT" (UNION IRON WORKS, SAN FRANCISCO, CAL., BUILDERS), AND U. S. TORPEDO BOAT "MORRIS" (HERRESHOFF MFG. CO., NEWPORT, R. I., BUILDERS).

The sea-going torpedo-boat must be prepared to perform two kinds of duty. It must be capable of making a torpedo attack upon the ships of the enemy, and must be prepared to stand guard over and protect from torpedo-boat attack the ships of its own side. To fill both these roles, it is necessary that it should possess the following features: (1) An efficient torpedo armament. (2) A gun armament sufficiently powerful for an attack upon other torpedo-boats. (3) High speed. (4) Sufficient coal capacity. (5) Good maneuvering qualities.

Torpedo Armament.—Torpedo experts are agreed that the long, 18-in. torpedo is the most desirable for this purpose. There remains to be considered the number of tubes which should be installed. The bow tubes which were at one time generally fitted have been abandoned on account of the interference of the bow wave with the tube and on account of the higher-speed boats running down the torpedo before it could gather way after being fired. Upon English, German, Italian, Russian, and our own first-class boats three training tubes have generally been installed. The Austrian, French, and Spanish boats of the same class, the English torpedo-boat destroyer and the German division-boat have but two each. There is very little experience upon which to base conclusions as to the necessary number of tubes. Provision for three torpedo tubes with a torpedo for each, and for carrying two additional torpedoes, is in conformity with the views of the greater number of the progressive maritime powers.

Gun Armament.—The boat requires to be provided with an armament which will enable it to encounter and disable or turn back a boat attacking vessels over which guard is being kept. The 1-pder. gun has been shown to be incapable of stopping a torpedo-boat. The 3-pder., possessing greater penetration and mining power, will. The guns and torpedoes will not generally be used at the same time. It is believed that three 3-pder. guns would make a battery which could be manned by the crew of the torpedo-boat, and which would be sufficiently powerful for its purpose.

Speed.—High speed is necessary in the sea-going torpedo-boat to make it meet three important conditions. The first is that it shall be in a class by itself, capable of refusing engagement with vessels of any other class than its own. The second requires that it shall be capable of approaching and getting away, in a torpedo attack upon ships, with sufficient rapidity to make the attack a success. The third condition is that when standing guard over ships to protect them from the attacks of torpedo-boats, it shall be capable of pursuing and engaging these boats. The speed of the fastest cruisers of the world, attained only by a very limited number, is 22 knots, so that a speed in excess of this is required in the sea-going torpedo-boat in order to meet the first condition. The experience upon which to base the limit of speed required by the second condition is not great. The "Almirante Lynch" and the "Almirante Condell" attacked and torpedoed the "Blanco Encalada" without requiring the full 20 to 21 knots of which they were capable. The maximum speed of the Japanese torpedo-boats which operated very successfully during the Japan-China war was 23 knots, and upon two occasions these successfully attacked and torpedoed vessels of the enemy. There seems reason to believe that the speed fixed by the first condition is not too low to be consistent with the second. The third condition requires a consideration of the boats with which our sea-going boats may be expected to contend. Of the more than 1,600 serviceavle torpedo boats which are now possessed, are building, or are projected by the nations of the world, there are but 260 having a speed of more than 25 knots. Of these, 153 are of the large size and high speed known in the English service as torpedo-boat destroyers, and 87 more are credited with a speed of but 26 knots. It is believed, therefore, that a speed of 26 knots would be sufficient to make our sea-going torpedo-boat capable of performing any service which is within her province. To produce the power necessary for this speed a single vertical engine possesses several advantages which recommend it for the purpose. It will require a smaller number of men to run it and keep it in order. The first cost of the single engine is very much less than that of two engines for the same power. The economy of the larger unit is superior to that of the smaller. The single engine admits of a roomier and more commodious engine-room than would be possible with a pair of engines in the same space.

Coal Capacity.—Ideas vary widely as to the necessary coal capacity which should be given to a sea-going torpedo-boat. It is necessary that, when such boats are acting with a fleet, the embarrassment occasioned by the necessity of their procuring coal shall be reduced to the least possible, by giving them as large a capacity as practicable and making some of the times of requiring coal by the torpedo-boat coincide with the times at which the larger ships of the fleet must seek coal. The normal endurance of our battleships of least endurance is about 7,000 nautical miles. It is not practicable to obtain so great a radius as this in the sea-going torpedo-boat. It is, however, possible to provide in the design of these boats for sufficient coal to steam 3,500 to 4,000 nautical miles at 10 knots. The sea-going torpedo-boat would then require coal with the battleships of least endurance and once in each interval between the coaling of these ships.

In connection with this matter of coal capacity, the possibility of torpedo-boats receiving coal at sea from ships should be noted. In the voyage of the English torpedo boats Nos. 61 and No. 62, previously mentioned, they received coal as they required it from the storeship "Tyne," which accompanied them, the coaling being performed without great difficulty, even during some of the very rough weather which was encountered.

Maneuvering Qualities.—The services required of the torpedo boat demands that it should be capable of maneuvering readily in a small space. To offset the disadvantage in this regard which is brought in by the single screw proposed, the fitting of a bow rudder in addition to the usual stern rudder and for use in conjunction with it is suggested. This arrangement has been in satisfactory use upon boats constructed by Normand and Schichad for some years, and has proved satisfactory and productive of considerable improvement over the maneuvering qualities of boats fitted with after rudders only.

A boat embodying the features which have been enumerated would, under the customary trial conditions with a load of 25 tons, representing the equipment, stores, coal, etc., on board, displace about 120 tons. The principal dimensions are:

Dimensions.	Ft.	Ins.
Length on the water line	141	0
Length over all	148	5
Maximum beam	15	6
Draft under screw	7	6
Displacement (trial)	127 tons.	
Speed	26 knots.	
Machinery.		
A single four-cylinder triple expansion engine.		
Cylinders 20 × 29 × 30 and 30 ins.		
Stroke	18 ins.	
Revolutions, not more than	400	
Indicated HP	2,700	
Two water tube boilers.		
Grate area, combined	110 sq. ft.	
Coal capacity	40 tons.	

Such a torpedo-boat could be constructed under the present industrial conditions for less than $100,000, so that at least two could be built for the cost of each of the largest of the boats which are now under construction for the navy. In the design outlined, the reserve of buoyancy is somewhat less than is commonly provided, although still more than 100% of the displacement of the boat is fully loaded. Provision is made for performing all the external service of the boat upon a platform which is raised some distance above the deck, so that although the reserve of buoyancy and freeboard are slightly less, the height of the deck upon which service is performed is more than is commonly provided in sea-going torpedo-boats. It is believed that boats similar in type to the one indicated would, with a well-trained crew, be fully capable of performing efficiently any duty which is within the province of the sea-going torpedo-boat.

The Harbor or Coast Defense Torpedo-Boat.

Our 3,000 miles and more of sea-coast, with its miles upon miles of inlets and shallow channels, innumerable small outlying islands, and its many harbors, great and small, at once require the protection and afford unequaled opportunities for the use of coast or harbor defense torpedo-boats. While France has available for this kind of duty one torpedo-boat for every 9 miles of coast line, Russia one for every 10 miles, and Great Britain one for every 17 miles, we, who may at any time be called upon to defend our coasts from the attacks of battleships and cruisers of an enemy, have not a single torpedo-boat specially constructed for this purpose, although there are under construction several which are applicable to it. Of the value, as a means of defense, of a large number of small torpedo vessels attached to and operating from coast stations as bases, there can be no question. They would attack ships of the enemy approaching the coast, and by their numbers and activity make anchorages on the coast absolutely untenable. Ready refuge in the shallow water of the many inlets or behind outlying islands or points of land would be always open to them.

Boats of this kind require: (1) An efficient torpedo equipment. (2) A light gun armament. (3) The least possible draught. (4) Good speed in deep and shallow water. (5) Good maneuvering qualities.

Torpedo Equipment.—It is not probable that more than one torpedo attack will be engaged in by this class of boat in each interval during which it is absent from its temporary or permanent base. During the Japan-China war, in an attack of Japanese torpedo-boats upon vessels in the harbor of Weihaiwai, which resulted in the sinking of the "Ting Yuen," seven participating boats fired eleven torpedoes. In the later attack upon the ships in the same harbor, which resulted in the sinking of the "Lai Yuen," the "Wai Yuen," and the tender "Paufah," four participating boats fired seven torpedoes. There is reason to believe that provision for two torpedo tubes for the long 18-in. torpedo, with one torpedo for each tube should be sufficient for these boats.

Gun Armament.—To provide the boat with means of embarrassing and keeping down the fire of an opponent when detached and chased by boats guarding ships which it is attacking, provision must be made for an armament which may be manned by the crews of the torpedo tubes, and which is capable of a rapid and fairly accurate fire. The machine gun seems to be the best arm for the purpose. A battery of three of these manned by the crews of the torpedo tubes should be effective.

Draft.—Boats of this class must depend to some extent for their safety upon their ability to elude chasing torpedo-boats and destroyers by running into shallow water. The draft should then be made as small as practicable. Since the change of trim occasioned by high speed in a small boat is accentuated in shallow water, it is necessary to provide for a form of stern which will reduce to a minimum this evil, and it may even be desirable to provide for some trim by the head in still water so that the maximum draft at full speed shall not be increased on account of this change of trim.

Speed.—The first two of the conditions fixing the limit of speed in the case of the sea-going torpedo-boat (the necessity of being in a class by itself and the necessity for sufficient speed to insure success in a torpedo attack), hold in the case of the coast or harbor-defense boat. A speed of 22 knots is believed to be consistent with these two requirements.

The operations of such boats as these are necessarily restricted to night or foggy weather, and all the time not occupied in attack is spent within easy reach of coal, which can be had at every port, large and small, along the coast. There is, therefore, not the necessity for large steaming radius which exists in the case of the sea-going torpedo-boat, but full speed may be expected to be more commonly employed than in the case of the sea-going boats. Coal to steam 15 hours at full speed should provide the means of striking quickly at a point some distance from the base and returning to the base after the attack.

A boat embodying the features enumerated above could be constructed to displace, under trial conditions, with a load of 10 tons representing ordinance, equipment, crew, coal, etc., on board, about 35 tons. The principal dimensions are:

	Ft.	Ins.
Length on the water-line	90	0
Maximum beam	11	3
Draught under screw	5	0
Displacement, trial	35 tons.	
Speed	22 knots.	
Machinery.		
A single triple expansion engine.		
Cylinders, 8 x 13 x 21 ins.		
Stroke	15 ins	
Revolutions	425	
Indicated horse-power	650	
One water-tube boiler.		
Grate area	30 sq. ft.	
Coal capacity	11 tons.	

Under the present industrial conditions such a boat could be built for from $25,000 to $30,000, so that a great number of them could be built at comparatively small cost.

In the preparation of a design for vessels of this class too great attention cannot be given to simplicity and adaptability of the weapon to the character of the men that will be available for duty with it in time of war. The coast or harbor defense torpedo-boat is a reasonable weapon to be placed in the hands of the Naval Reserve and of men who lay aside their peace-time occupations to defend the country. It is essentially a fair-weather boat, because weather conditions too severe for a small fast boat are too severe for the successful use of torpedoes. The machinery in the design sketched above is similar to, although more powerful than, that commonly found in small high-speed yachts, and men who are now serving in such yachts would, with a short training under an engineer officer of the navy, be competent to take and run efficiently the machinery of these small torpedo-boats. The deck force could, in part at least, be equally readily recruited from the men who in time of war lay aside peaceful occupations to take up the defense of their country.

It is with some misgivings that the two designs outlined above are brought to notice. War experience with the modern torpedo-boat has been extremely limited, and, in fixing upon boats for our service, it is necessary to consider, not only such limited experience as there is, but the possible and probable requirements which must in time of war be met by them. The definite serious purpose of the torpedo-boat cannot be lost sight of, and it must be designed to fulfil this purpose in the best and most economical way. While it is believed that the types outlined are the logical result of a consideration of the requirements, the two designs are laid before the Society in the hope that a clearer understanding of the needs of the navy in this important branch may be reached through the consideration which may be given them rather than from any special merit in the particular designs themselves.

TABLE I.—SHOWING DIMENSIONS, ARMAMENT, MACHINERY, ETC., OF THE TORPEDO BOATS OF THE UNITED STATES NAVY.

	"Cushing."	"Ericsson."	Nos. 3, 4 and 5.	Nos. 6 and 7.	No. 8.	Nos. 9 and 10.	No. 11.	Nos. 12 & 13.	No. 14.	Nos. 15 & 16.	No. 17.	No. 18.	No. 19.	No. 20.	No. 21.
Date when built	1890.	1891.	1895.	1895.	1895.	1896.	1896.	1896.	1896.	1896.	1896.	1896.	1897.	1897.	1897.
Length, ft.	137.5	150	160	175.5	170	147	210	146	139	100	101½	101½	225	191⅔	205
Beam, ft.	14¼	15½	16	17½	17	16⅔	20	14½	15	12	12½	12½	21.3	20⅙	18¼
Draft, ft.	4⅞	4⅝	5	6¾	5½	4⅝	6	5.17	4 1-12	3⅝ ins.	4¼	4¼	5	6	6
Displacement, tons	105.3	120	143.9	162	184	143.3	240	110.4	103	46½	65	65	340	247.5	235
Armament	3 1-pdrs.	4 1-pdrs.	3 1-pdrs.	3 1-pdrs.	4 1-pdrs.	4 1-pdrs.	6 6-pdrs.	3 1-pdrs.	3 1-pdrs.	1 1-pdr.	1 1-pdr.	1 1-pdr.	7 6-pdrs.	4 6-pdrs.	4 6-pdrs.
Torpedo tubes, size, 18-in.	1 bow, & 2 deck.	1 bow, & 2 deck.	3	3	3	3	2	3	3	2	2	2	2	2	2
Designed speed, knots	22	24	24½	27½	26	30	30	22¼	22½	20	20	20	30	..	..
Designed I. HP.	1,750	1,800	2,000	3,400	3,200	4,200	5,600	1,750	1,750	850	850	850	7,200	..	5,600
Weight of hull, tons	33.7	49.20	93.1	56.5	65[1]	44.55[2]	85[1]	42.6[1]	36.6[1]	14.2[1]	..	..	..	..	..
Propelling machinery, tons.	54.5	58.46	50.82	76.8	92[1]	78.20[2]	120[1]	57.1[1]	48.7[1]	21.7[1]	..	..	..	..	..
Trial load, tons	17.3	17.5	30.5	29½	27.32	20.29	35	20	20	10½	..	..	60	41.6	41.5
Bunker capacity, tons.	39	35	44	60	60	32	80	40	28	8	..	..	..	131	..
Diameter of cylinders:*															
H. P., ins.	11¼	11½	12	16	14½	17¼	20	11⅞	12½	12½	12	12	21.5	19.5	20
I. P., ins	16, 22½	16, 21½	19¼	22	22	24¾	29	19	18	18	19½	19¼	32.5	31.75	29
L. P., ins.	22¼	30	22	25	25¾	37	39	22⅞	25	25	22	22	34	35	30
Stroke, ins.	15	16	16	16	18	21	18	15	13½	13½	16	16	18	18	18
Revolutions per minute.	375	385	395.7	389, 396	395	340	400	395	410	400	350	350	400	..	400
Number of boilers	2	2	2	3	3	2	3	2	2	1	2	..	4	..	..
Kind of boilers	Thorny-croft.	Thorny-croft.	Mosher.	Du Temple.	Mosher.	Nor-mand.	Thorny-croft.	Thorny-croft.	Du Temple.	Du Temple.	.....	.....	Thorny-croft.	.....	Seabury.
Grate surf., each boiler, sq.ft.	38.65	42.5	45.5	53½	47	55	66	74	40	38	..	40	67.8	..	..
Heating surface, sq. ft.	2,252	2,349	2,630	2,710	2,630	2,580	4,000[5]	2,426	1,932	1,850	..	2,100	..	..	..
Boiler pressure, lbs.	235	250	240¼	214	250	3,400 230	240	250	225	225	..	250	240	..	245
Weight eng., condenar, etc, tons	34.0	..	31.62	42.50	56.5[4]	47.55[4]	63.51[4]	30.22[4]	..	..	..	..	..	..	..
Boiler, water & fitgs, tons.	20.50	..	19.20	34.30	35.50[4]	30.65[4]	56.40[4]	26.78[4]	..	..	..	..	..	..	..
Number of screws	2	2	2	2	2	2	2	2	2	1	..	..	2	..	..
Of blades	4	..	3	3	4	3	3	3	..	..	..	..	..	..	..
Pitch, ft.	8.417	7⅞	7⅞	9	8⅝	10⅜	8⅝	7¼	..	..	..	..	..	..	..
Diameter	4½ ft.	4⅝ ft.	5¼ ft.	5½ ft.	6 ft.	6½ ft.	6⅝ ft.	5⅛½ ins.	..	..	..	..	..	..	..
Blade area, sq. ft.	9.3[3] 6.12[3]	8.5[3]	9.68[3]	7.1[3]	11.32	..	9 & 6.4[3]	8.5[3]	..	..	..	..	..	..	..
Slip, per cent.	27	..	19.81	..	..	..	..	..	..	..	..	..	..	..	..
Piston speed, ft. per minute	935	1,020	1,056 1,037	..	..	..	..	..	..	..	..	..	..	..	..

* The "Cushing" has quadruple expansion cylinders; all others quadruple. [1]Projected. [2]Helicoidal. [3]Developed. [4]Estimated. [5]Outside.

Note.—Boats Nos. 8 to 21, inclusive, are not yet completed and the elements given are as designed.

The builders and boats are: Herreshoff Mfg. Co—"Cushing," Nos. 6, 7, 14, 15 and 16; Dubuque Iron Works—"Ericsson"; Columbian Iron Works—Nos. 3, 4, 5 and 18; Moran Bros.—No. 8; Bath Iron Works—Nos. 9 and 10; Union Iron Works—No. 11; Wolff & Zwicker—Nos. 12, 13 and 20; Hillman & Sons—No. 17; Harlan & Hollingsworth—No. 19; Gas Engine & Power Co.—No. 21.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post Office as Second-Class Matter.

Published every Thursday

at St. Paul Building, 220 Broadway, New York, by

THE ENGINEERING NEWS PUBLISHING COMPANY.

D. McN. STAUFFER, Vice-President, CHARLES WHITING BAKER, Secretary, } - - EDITORS.

GEO. H. FROST, President, F. P. BURT, Treasurer, } - - - BUSINESS MANAGERS.

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ALFRED E. KORNFELD, New York, F. A. PECKHAM, Chicago, } - ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, ST. PAUL BUILDING, NEW YORK.
WESTERN OFFICE, MONADNOCK BLOCK, CHICAGO.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.60 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

Mailing addresses may be changed at will by sending both old and new address. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug. 12) of the year 1897; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page 28. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

In our editorial review of Major Symons' report on the Deep Waterway problem last week, we pointed out that the freight rates on grain from upper lake ports to Buffalo are actually less per ton mile than the freight rates on grain crossing the Atlantic. But all achievements in the cheap transportation of bulk freight that have ever been recorded are likely to be distanced by what will be done on the lakes by vessels now under construction. The firm of F. W. Wheeler & Co., of West Bay City, Mich., are now building three boats, a steamer and two schooner consorts for the Bessemer Steamship Co., which will eclipse in size anything afloat on the lakes and will be able to carry 20,000 tons of ore at a trip, on a draft of only 17 ft. of water. It is estimated that these vessels can make 20 round trips in a season, and at the above stated capacity can carry the enormous amount of 400,000 tons of ore in a season from the Lake Superior ports to the ore receiving docks on Lake Erie. The cost of the three vessels is said to be between $500,000 and $600,000, or only $25 to $30 per ton of carrying capacity on 17 ft. draft. The steamer will be 475 ft. in length over all, 50 ft. beam and 29 ft. deep. The schooners will have the same beam, 6 ins. less depth in the water bottoms and will be 450 ft. over all. It is stated that the Bessemer Steamship Co. contemplates ordering another pair of boats, a steamer and a consort of the same dimensions as those above described, very shortly.

With such vessels as these moving freight on the lakes it is evident that the cost of moving coal and ore will be reduced to figures that a few years ago were not dreamed of; and yet these feats are being accomplished on a draft of only 17 ft.

We pointed out also, in our last week's editorial, that one chief reason for the cheapness of Lake transportation is the remarkably efficient systems which have been developed for loading and unloading vessels. An excellent illustration of the feats which are now accomplished in handling bulk freight, is the statement that at the Duluth, Missabe & Northern Ry. dock at Duluth, recently, 41,500 gross tons of ore were put on shipboard in 24 hours, a feat which is said to beat the record. We need but to compare such a process of lading a vessel with the tedious work of stowing away cargo in the hold of an ocean steamer to appreciate one reason why the latter would not find it economical to go to Duluth for a cargo, even if a free deep waterway were open to her.

Native professional services are not rated very highly in India, according to the "want" column in a copy of the Calcutta "Chronicle," now before us. An "estimator and draftsman" is offered 30 rupees, or $12 silver, per month; a man expert in the use of the plane-table and prismatic compass can make 80 cts. per day, and $20 to $26 silver per month is deemed sufficient compensation for a man fitted to occupy the position of "head clerk and engineer" on municipal work. From the standpoint of Western salaries paid these sums seem very small indeed; but it must not be forgotten that in Eastern countries the wants of the natives are fewer and are more easily met and that the purchasing power of the money, for the necessaries of life, at least, is considerably greater. And it should also be remembered that the official pay of a Captain of the Royal Engineers, in the British army, is only $2.78 per day, or say $85.00 per month. This is about one-half of the pay of an officer of similar rank in the United States Army in the first five years of service in that grade. In the matter of compensation everything is relative, and 4 annas, or about 12 cts. silver per day is considered ample pay for good common labor in India; and consequently, to this laborer, the pay of his professional brother assumes princely proportions.

Philadelphia, with more than a million inhabitants, has owned and operated its water-works for almost a century. A number of ordinances are now before the city council containing as many plans for the development of a new and improved supply by some private company, the city to pay for the water either by the million gallons or by a lump sum without regard to the quantity supplied. A report on some of these schemes has recently been made by Mr. Thos. M. Thompson, Director of Public Works, as was briefly noted in our issue of Oct. 14. This report includes one from Mr. Jno. C. Trautwine, Jr., Assoc. Am. Soc. C. E., Chief of the Bureau of Water, and others from a number of experts on water purification. So far as water purification is concerned, the tenor of Mr. Thompson's report is in favor of slow sand filtration. With this phase of the subject we shall not concern ourselves, nor shall we consider the various propositions in detail. What we do propose to discuss is whether Philadelphia is approaching its water supply problems in the right way, in the light of engineering knowledge and the experience of other cities in the same line.

For many years Philadelphia has been discussing its needs and possibilities in the way of a purer water supply. A small part of the water consumed in the city is taken from the Delaware River and the balance from the Schuylkill, all being pumped at various stations within the city. It has long been recognized that both sources of supply are subject to serious sewage pollution, besides which the supply from the Schuylkill is limited in quantity. The Schuylkill comes from the coal regions, and in recent years has been black with coal-dust at times of high water. Several distant sources of supply, naturally pure, have been seriously considered, but any of these would be very expensive.

In the last five years or so a filtered supply from either the Schuylkill or Delaware has been growing in favor. The filtration of the water supply of so large a city as Philadelphia never having been tried in this country, although it has been done with success abroad, the water officials of that city have made several different requests for appropriations to enable them to put in a filtration plant for a part of the supply, so that filtration might be tested in advance of adopting the system for the whole city. None of these requests ever came to anything. With the agitation for a filtered supply various companies have come forward with offers to supply the city with filtered water. The present indications are that unless a strong public sentiment to the contrary shows itself, councils will accept some one of the propositions now before it, and virtually turn over the filtration and pumping of water to a private company.

This journal has long maintained that the water supply of a city should be wholly under municipal control wherever local circumstances permit. This is especially true where questions relating to the purity of the supply are involved, for at no other point is the health of a community so vitally affected as in its water supply. It is true that the Philadelphia water supply under municipal control has long been polluted and dangerous, but the class of officials who have been responsible for this condition cannot be relied upon to compel a private company to perform any agreements it may make with respect to the purity of the supply. Whenever the people as a whole demand an improvement, public officials are at least as likely to respond as are the managers of a private corporation working under a contract. Further, if public officials do not respond to public demands, the people can put them out of office if they choose. But no such course is possible when a private company has the contract for a city's supply.

We are aware, however, that a number of the city's officials profess to believe that the best interests of the city require the turning over of the water-works to a private corporation. The question arises, are they acting in good faith? If they are, why do they not take steps to protect the city's interests in making such a transfer? So far as we have been able to ascertain, the city councils have thus far taken no steps to secure for the city the most advantageous terms financially from the various bidders, or to secure from them any effective safeguards as to the purity of the new supply. Thus far it has not been the city council that has taken steps to secure a better supply, but private interests; not the buyer, but the seller. Instead of first investigating the whole subject carefully, determining what is best for the city and asking for competitive bids on one specific and carefully prepared plan, the city allows anybody to present to it any sort of a plan, and the amount of consideration a scheme gets from councils seems to depend very largely upon the political backing of those behind it.

So far as can be judged from Mr. Thompson's report, not one of the plans there outlined is sufficiently definite to enable an engineer acting as adviser to the city to pass on its merits, except to condemn it either for what it contains or for what it lacks. In addition, the propositions are so diverse in both the mode of supply and compensation, as to make comparison of their merits impracticable. It is certain that competitive bids on properly drawn specifications would result in a number of proposals far more advantageous to the city than any now before it.

The three great faults in Philadelphia's present supply are excessive waste, bad quality and an inadequate distribution system. The average water consumption in Philadelphia per head per day in 1896 was 172 gallons. If this were cut down to 100 gallons, as a maximum, which doubtless might be done by restraining waste, but without restraint upon actual use, the saving in pumping expenses would in itself pay the cost of filtration, and at the same time the deficiencies in the distributing system would be to a large extent removed.

Looking at the question from a broad aspect, the proposal of this great city to turn over its water supply to a private corporation is directly contrary to the modern trend in municipal government, and against all sound ideas of public policy. The citizens of Philadelphia can rest assured that the promoters of the many different companies which are now seeking to get control of Philadelphia's water-works are not actuated by purely philanthropic motives. They expect to get enough out of Philadelphia's citizens to pay not only the entire cost of furnishing them a water supply, but also interest on the company's bonds and dividends upon its capital stock; and if they secure control of the water-works there is no fear but what they will be successful. The question which forces itself upon any one is: If so many different corporations see such a rich thing in Philadelphia's water-works plant, is it not pretty good evidence that the city had better hang on to it?

PLANS FOR INCREASING TRANSPORTATION FACILITIES IN AND ABOUT NEW YORK; EAST RIVER TRANSIT.

The chief difficulties which lie in the way of supplying transportation facilities between the cities centering about Manhattan Island arise from the necessity of crossing the North and East Rivers, both of which are navigable waterways of great commercial importance. The East River along the New York water front is nowhere less than 1,500 ft. wide, and the width of the North River, between pier lines, is fully twice this distance. Up to the present time, as is well known, the navigation interests have succeeded in putting down any proposal to obstruct or to narrow either river by a bridge pier. It may, perhaps, be open to question whether the objections commonly urged against such a construction are quite so valid as many persons seem to believe, when all classes of interests are given fair consideration, but the fact nevertheless remains true that they have controlled the designs of the crossings thus far proposed.

All the plans now before the public for crossing the East and North Rivers, therefore, necessarily propose either a single span bridge at a high enough level above the water to permit the passage of vessels with masts, or else a tunnel underneath the river bed. Engineers will hardly need to be told that the cost and engineering difficulties of building such structures, with their terminals in a closely built-up city are very great, and it is quite as plain that their construction is warranted only by the demands of a great traffic.

Despite the magnitude of the problem, perhaps, indeed, in a measure because of it, propositions to bridge or tunnel the North and East rivers have been plentiful ever since the present Brooklyn Bridge was proposed in 1867. In frequent succession there have come before the public the Hudson River Tunnel, the North River Bridge, the New York and New Jersey Bridge, the Blackwell's Island Bridge, the new East River Bridge, the Long Island R. R. tunnel, and a number of other projects, all of which have reached some stage of advancement and are still in some measure demanding public attention. The story of the rise and growth of these various schemes will sometime make an interesting chapter in the history of Greater New York, but it is now too recent a matter to need telling here. It is, however, a matter of great interest to the people of New York and to engineers all over the country to know exactly how these projects stand at present and what their future prospects are.

With this idea we have been at some pains to collect such information as is available about the present standing of each scheme, and to present it here with such comment as seems to be called for. The large number of projects and the space required to describe each fairly, makes it necessary to divide the discussion. In this issue, therefore, attention will be confined to a consideration of the various schemes for extending transportation facilities between New York and the western end of Long Island, comprising Brooklyn, Long Island City, and a large number of suburban towns. In a succeeding issue the various projects for crossing the North River will be considered.

In the accompanying map we show the boundaries of the five "Boroughs" comprising Greater New York, and also the adjacent parts of New Jersey, including Jersey City, Hoboken, Newark, Paterson, Passaic, and a host of smaller towns, which, while they lie outside of its boundaries, are almost as much tributaries of New York as is the west end of Long Island. The routes of the various bridges and tunnels proposed across the North and East rivers, and that of the proposed underground rapid transit railway in New York, are shown by heavy full and dotted lines, respectively. Distinctive symbols show the elevated and steam railways tributary to different sections of the territory and the present location of their terminals in relation to the proposed river bridges and tunnels. A series of concentric circles spaced one mile apart gives a rough idea of the available area for population within any given distance from the New York City Hall, and an idea of the relative density of the population at various points may be had from the following table showing areas and population:

Greater New York: Borough.	Area in acres.	Population.
Manhattan	13,487	[1]1,750,000
Richmond	36,001	[2]65,000
Brooklyn	42,095	[3]1,150,000
Bronx	25,270	[4]125,000
Queens	79,347	[2]118,000
Total	196,800	3,208,000
New Jersey Counties:		
Bergen		56,671
Essex		307,200
Hudson		330,000
Passaic		126,000
Union		87,000
Total		[4]908,871

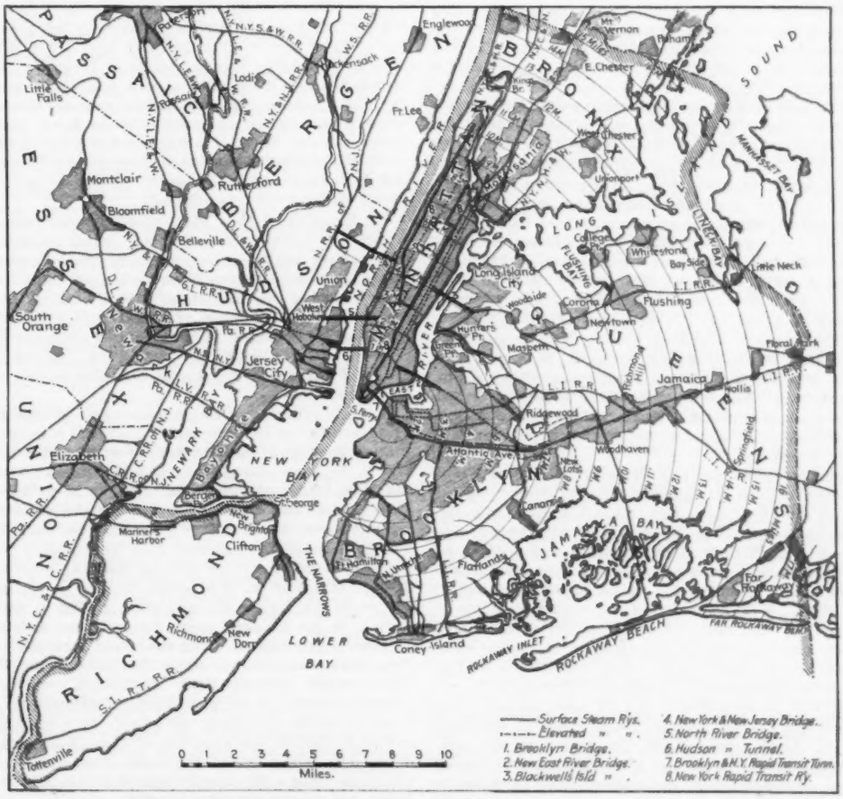
Note: [1]Police census of 1895; [2]estimated, 1896; [3]estimated, 1897; [4]estimated from 1890 census, allowing 20% increase.

From the map and tables a very fair idea is had of the population which bridges and tunnels across the North and East rivers now have to draw upon for local traffic, and also of the extent and character of the territory which remains to be developed for suburban residence.

Setting aside rapid transit which is purely interurban, such, for example, as that lengthwise of Manhattan Island, the greatest need and opportunity for improved transportation facilities anywhere within the territory of Greater New York are evidently between New York and Long Island. As long ago as March 17, 1888, Engineering News pointed out this fact, and some of its older readers will doubtless recall the colored map published at that time to show that New York had an area of only nine square miles within a radius of eight miles from the New York City Hall, but that Brooklyn had an area of 64 square miles within the same distance of the same point. In order that the people of New York might realize the full value of this heritage, it was shown that improved transit between Brooklyn's great residence area and the business section of New York was absolutely necessary.

It will be seen from this that in the earlier days of the "Brooklyn Bridge problem" the fact now being so loudly proclaimed by the daily papers was probably quite as fully realized by some of its students as it is to-day, but as we have clearly pointed out in our issue of Jan. 7, 1897, everybody seems to have been singularly blind to the fact that what the future demanded was not a quick and comfortable handling of passengers from one bridge terminal to the other, but through transit between New York and Brooklyn without change of cars and for one fare. As most of our readers are aware, this greater improvement is now about to be secured. In our issue of Aug. 26, and more fully in another part of this issue, the plans by which Brooklyn's elevated and surface railway cars will cross the bridge and land their passengers at the New York terminal are briefly described.

When one considers the obvious advantage of this plan for through transit, and the comparatively reasonable expense compared with the old terminal station plan, at which it can be carried out, it becomes a matter of exceeding wonder that it was not thought of before. Perhaps no one plan of city transit in this country has received more serious consideration and discussion at one time and another for the past ten years than the improvement of train service on the Brooklyn Bridge.



MAP OF GREATER NEW YORK AND ADJACENT NEW JERSEY COUNTIES SHOWING LOCATION OF PROPOSED BRIDGES AND TUNNELS ACROSS THE EAST AND NORTH RIVERS.

The talents of some of the best-known engineers in the country have been devoted to the problem, and solutions by the dozen, both official and unofficial, have been proffered, but all of them have stopped short at the ends of the bridge. Just which of these solutions was the best for its intended purpose we need not trouble ourselves about now, but it is surely worth noting that to a great extent all of them owed their difficulty very largely to the failure to grasp the possibilities of through transit.

It is for these reasons that the present arrangements for making the bridge a thoroughfare assumes an immediate importance superior to any other plan for securing rapid transit between New York and Long Island. The engineering details of the plan are described elsewhere and need not be repeated here. In some respects, it may be, there is room for criticising the mode of solving certain of these details, but there can be no question, we think, that the broad idea of making the bridge an integral part of Brooklyn's street railway system is an excellent one. Not the least of the benefits to be anticipated, we believe, is that it has

established a standard of continuous single fare rapid transit across the East River to which all subsequent schemes will have to conform.

As stated in another column, the contracts require that through transit shall be in full operation within a year by the elevated railways and within six months by the surface lines. With these betterments completed the citizens of Greater New York can look for no further improvement in transit across the East River until the completion of the new East River Bridge, or one of the tunnels, of which there are now two with some prospect of being carried out. The possibility of improved ferry service exists, it is true, but this service has the very great drawback of two separate fares and a break in the journey, and with the strong competition of single fare, through transit by tunnels or bridges, the people can hardly expect much development of the ferry service for passenger transportation.

Of the East River tunnel schemes the one which promises most is without much doubt the Brooklyn & New York Rapid Transit tunnel, connecting the Long Island R. R. station at Flatbush Ave., in Brooklyn, with Cortlandt St., in New York. The plans for this work, which were reported by the special rapid transit commission appointed by the Mayor of Brooklyn, were described in our issue of Jan. 14, 1897.

To understand the significance of the proposed work clearly, it is necessary to review briefly the present conditions. Formerly the Long Island R. R. had a line of steam cars running the whole length of Atlantic Ave., in Brooklyn, down to South Ferry, but many years ago it was compelled by legislation to stop running its cars below Flatbush Ave., and it, therefore, established its present terminal station at the junction of Flatbush and Atlantic avenues. From this station to East New York the double track line of the company runs at grade along the center of Atlantic Ave. For many years accidents have been frequent at the streets crossing Atlantic Ave. at grade, and the sentiment has been growing stronger every year in favor of compelling the railway to abolish its grade crossings. This sentiment finally crystallized in the appointment of the commission just mentioned.

Briefly stated, the solution which this commission suggested was as follows: To construct a tunnel from the Flatbush Ave. station underneath the East River to New York, with underground stations at the City Hall, in Brooklyn, and at the corner of Maiden Lane and Pearl St., in New York. From the Flatbush Ave. station in the opposite direction it is suggested that the tracks continue in a subway and open cut to the street surface, and then gradually rise to an elevated structure running along Atlantic Ave. until well outside of the present thickly-settled portion of Brooklyn.

It will be seen that in a very large measure the prospects of this scheme hinge upon the attitude of the Long Island R. R. Co., and it speaks well for the prospects of the plan that the officers of that company fully appreciate the advantages which would accrue to their property by the successful carrying out of the enterprise. To develop fully the capabilities of its tributary country for suburban residence the Long Island R. R. must have an entrance into New York and Brooklyn which will not necessitate a break in the journey. At present this interruption and the slowness of the ferry and surface railway connections prohibit all but the most favorably situated business men from locating in the suburbs of Long Island.

Outside of pure business interests, however, the Long Island R. R. has a special inducement to accept and carry out the tunnel scheme in the fact that it will stop once for all the antagonism and litigation which its present occupation of Atlantic Ave. at grade has entailed. Already the company's most valuable hold on this thoroughfare, by which it reached the water front of New York Harbor, has been wrested away by legislation, and threats are made by the people to take away still more of its franchises if it resists the attempts of the city to clear Atlantic Ave. of grade crossings, which the proposed tunnel scheme will do. Outwardly, at least, the railway company expresses a favorable attitude toward the tunnel, and its officers maintain that the work will receive their full co-operation, but insist that the scheme is too large a one to undertake without a definite agreement between all the parties interested, and a careful provision for the cost and engineering difficulties. Certainly no one can deny the justness of this contention. When, too, it is borne in mind that there are five large interests deeply concerned in the work, viz.: The Long Island R. R. Co., the Atlantic Ave. R. R. Co., and the Nassau Electric R. R. Co., to which the electric lines on Atlantic Ave. are leased; the Brooklyn & New York Tunnel Co., organized to build the tunnel, and the city of Brooklyn, it can be readily understood that a great deal of work is required to harmonize all interests and get the enterprise in a position for active prosecution.

The standing of the whole project is at the present time about as follows: Within the last fortnight the tunnel company has filed with the Brooklyn Board of Aldermen an application for an ordinance permitting the tunnel to be constructed. In asking for this legislation, President W. H. Baldwin, Jr., of the Long Island R.R. Co., stated that the intention of the company was to push the preliminary work and to proceed toward actual construction as rapidly as possible. The Board of Aldermen has held one public hearing to receive arguments for and against the legislation asked for, and at this meeting almost no opposition to such legislation was developed, while a number of arguments in its favor were presented. As yet the Aldermen have not acted on this petition, but it seems pretty certain that the ordinance will be granted. Such an action seems eminently to be desired.

The Brooklyn & New York Rapid Transit tunnel is without question one of the most notable schemes yet projected for extending the transportation facilities between New York and Long Island. Besides the important benefits which will come from the abolition of steam railway grade crossings in Brooklyn it opens direct communication by railway with the numerous suburban towns of Long Island from the business section of New York.

The only scheme which presents any prospects of advantage at all comparable with the proposed tunnel for a New York entrance for the Long Island R. R. is the Blackwell's Island Bridge across the East River at about 64th St. in New York. This bridge was actively pushed by the railway company some three or four years ago, but nothing has been done for some time and the company informs us that it will do nothing more at present. The great objection to a bridge located so far up the river, as far as the suburban traffic is concerned, is its distance from the business district of Manhattan Island. For the great majority of New York business men using the Long Island R. R., it would offer but little advantage over the present routes, and for the Brooklyn business man it would hardly be of any use at all. It is evident, however, that if the overflow of New York residents onto Long Island continues, that the time will come when a Blackwell's Island Bridge may be demanded by the suburban traffic.

The second of the East River tunnel schemes which needs to be mentioned is one which has long been familiar to New York people as the Henning Gravity Tunnel, crossing the river just below and nearly parallel to the present Brooklyn Bridge. In 1896 the names of several prominent engineers and business men became connected with this scheme, and an ordinance permitting its construction was secured from the Board of Aldermen of New York. A similar ordinance permitting work on the Brooklyn side of the river was refused by the aldermen of that city, but owing to the very curious and not generally known fact that the city of New York extends to the old "low water line" of Brooklyn, within which is now included a considerable part of the water frontage on the Brooklyn side, it was found possible by turning the tunnel parallel to the river at the Long Island end, to keep on property not under the control of the Brooklyn Board of Aldermen. The ordinance granted by the New York Board of Aldermen, therefore, gives the company all the rights necessary for construction, even if the coming consolidation of the two cities should not furnish a solution for the difficulty.

In its earlier days the Henning tunnel had no further purpose than to get passengers across the river in competition with the Brooklyn Bridge. The projectors refuse to make known the present plans and prospects of the company, but so far as can be learned, through transit is not now proposed. As we have already stated, the day when the mere handling of people across the East River will satisfy the demands for rapid transit to and from Long Island has had its knell sounded by the through transit arrangements of the Brooklyn Bridge.

The last of the proposed plans for transit across the East River that we need to mention is the new East River Bridge, now in process of construction. The structural features of this bridge have been noted at various times in Engineering News. It is, of course, too early yet to say exactly what the connections will be between the new bridge and the railway on the two sides of the river, but it is assured that through transit for both elevated and surface lines will be provided. The bridge itself will have two tracks in the middle for elevated trains alone, and on each side of these two tracks for the surface cars, making six tracks in all, but it will not provide power for operating trains on any of these tracks. We are reliably informed that the prospects are that all the surface and elevated lines in the eastern section of Brooklyn will use the bridge tracks, and that it is known that on the New York side both the Manhattan Elevated Ry. and the surface lines have made studies for connections. Of all the proposed new East River crossings this bridge is the only one now under actual construction.

In glancing back over the various propositions for improving transportation facilities across the East River, between New York and Long Island, the first feature, perhaps, that strikes the engineer is that all but one are essentially continuations of existing steam or street railway systems. The old idea of building a structure whose sole purpose should be to handle passengers from one side of the river to the other and then drop them, has been almost wholly abandoned. We think that most people will admit that the advance is one to be entirely approved. In the nature of things the west end of Long Island must in the future house a larger and larger proportion of those doing business on Manhattan Island. For people of small or moderate incomes, no part of the territory surrounding New York is so easily and cheaply reached, and nowhere within the same distance of New York is residence land so inexpensive and so plentiful. The very wealthy man and the man who prefers more rural surroundings, and has the means to gratify his tastes, will, perhaps, prefer to go elsewhere, but for the great mass of people who desire better homes than the flat-houses and tenements of New York, Brooklyn and its suburbs furnish the best opportunities for making them. With these people the items of time and expense are of chief importance in transportation facilities, and it is evident that both of these items are greatly reduced by routes providing single fare, through transit from New York to all parts of the great residence district of Long Island.

LETTERS TO THE EDITOR.

A Long Day's Run by a Steam Motor Carriage.

Sir: With reference to the letter published in your issue of Oct. 28, I would say that the distance from Boston to Claremont, N. H., by turnpike, as run by the motor carriage, is about 100 miles—not 125, as stated last week by your correspondent at Sunapee. The run was a good one over a heavy road and there was no need for overstating the distance, which is somewhat greater by rail via Concord, N. H. L. W. Densmore.

Hillsboro Centre, N. H., Nov. 1, 1897.

What Causes High Magnetic Quality in Steel?

Sir: My attention has been attracted by the letter from Edgar Allen & Co., of Sheffield, England, on p. 298 of your issue for Nov. 4, and your comments thereon. In the line of the letter of Allen & Co., I wish to say that the results of Prof. Ewing's tests of the magnetic quality of Allen steel show it to be superior to any steel castings made commercially in this country. The high magnetic quality apparently is due to unusually small percentages of impurities and unusual soundness in the castings. I have not had the pleasure of making tests on

Allen steel myself, but Prof. Ewing's name is ample assurance of the reliability of his tests. My own tests have included test pieces from castings made by a considerable number of American steel plants in which a variety of processes are used. No samples which I have ever had, which came from commercial product, have equalled the Allen steel in magnetic quality (or, indeed, in chemical purity), though I have tested many bars which are representative of the best product of the steel foundries acknowledged to turn out the finest magnetic product in the country. It is apropos to say that bars from a foundry using the Robert process or a modification thereof, which I tested some time since, showed no advantage in purity or magnetic permeability over open hearth castings made from similar materials.

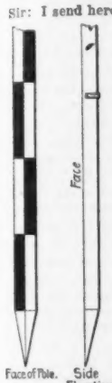
The unusual magnetic quality and chemical purity of the Allen steel as shown by Ewing's tests may not be due to the metallurgical process used, but there surely is a marked difference between this product and that of our open hearth furnaces and converter processes. If this difference is not due to the process, what is the cause? An answer to this question is of considerable interest, at least from the academic side. Respectfuly yours,

D. C. Jackson.

University of Wisconsin, Madison, Wis., Nov. 6, 1897.

A Sight Pole for Work Requiring Great Accuracy.

Sir: I send herewith a drawing of a sight pole to be used with a transit where it is desirable to do very accurate work. In designing this pole my object was to have a plain surface presented to the observer, and one in which the reference line in the center of the surface will always pass through the point of the pole, no matter at what angle the face may be to the observer so long as the face is turned toward him, thus doing away with the phase error, which gives trouble with round or octagonal poles. As seen by the drawings, the pole is triangular in section and the point is in line with the face. The bubble-tubes on the back enable the flagman to hold the pole vertical.



Sight Pole for Accurate Transit Work.

The heavy metal point should have the center line of the pole scratched into the metal and when the point becomes dull from use it can be sharpened again by grinding off the two rear faces until a new point is formed on this scratch, which will be in the same vertical line as the old one.

Respectfully, C. K. Allen.

Mexico, Mo., Oct. 23, 1897.

Bicycle Surveys.

Sir: In regard to bicycle surveys, mentioned in your issue of Nov. 4, the writer would state that during the summer of 1896 he made a bicycle survey of the roads in Caroline County, Md.—about 560 miles.

A pocket compass was used, and the roads plotted in the field on topographical paper to a scale of 2 ins. to the mile. The plotting was done by means of a small protractor and a scale 2% shorter than the scale of the map; the cyclometer having been found to register 2% too much. Except on very crooked roads the error of closure rarely exceeded 1½% or 2%. No levels were taken, but all streams and houses were located.

Twenty miles was an average day's work, though much more was done under favorable conditions. Yours truly,

M. L. Saulsbury.

Westfield, N. J., Nov. 8, 1897.

(The article referred to, in our issue of Nov. 4, has also called out a letter from Mr. Ellis B. Noyes, M. Am. Soc. C. E., of 409 Middle St., Portsmouth, Va. With the letter Mr. Noyes sends the copy of a patent, taken out by him and Mr. Charles W. Smith on Aug. 11, 1896, illustrating and describing an attachment to a bicycle intended for more elaborate surveying purposes. Briefly noted, this machine for automatically plotting topographical sections consists of recording mechanism connected with the measuring driving wheel of the bicycle. The details of this mechanism are somewhat too complicated for verbal description, and we must refer those interested to the patent itself, which is No. 565,695. As to results obtained, Mr. Noyes says that the machine itself will record upon section ruled paper correct horizontal distances and contours. By noting on the sheet compass directions forward and back at each change of direction, a complete detail of the line is obtained. Side topography can be either noted in a book, or directly upon the machine sheet under some conditions. The inventors believe the machine would be useful in topographical work on State surveys and in preliminary work for parks, railways, etc.—Ed.)

Thermo-Electrical Tests of Iron and Steel.

Sir: In the review of the paper written by me on the thermal condition of iron and steel under stress, which was published in your issue of Oct. 28, 1897, there are a few statements that appear misleading and which, with your usual fairness, I am sure will be modified. Regarding the use of the thermopile: This was used only in investigating the girder where we had a longer circuit and wished a greater electro motive force than could be obtained with the thermal couples. The thermal couple used in the writer's experiments consisted of an iron and a German silver wire soldered to the test piece. This arrangement makes an excellent junction, giving reliable contact, and is little affected by radiant heat as compared with the thermopile. Regarding the amount of temperature change: Roughly, 75 lbs. per sq. in. will produce a temperature change of one thousandth degree Fahrenheit, and for a stress of 15,000 lbs. per sq. in. the temperature change would be 0.2° F., so that the quantities to be measured are greater than might be inferred from your review.

You state that the low limit of strain at which the thermal condition of the metal ceases to be an accurate index of the intensity of the internal stress, would seem to take the thermal method out of the field as a practical commercial test for structural material. Since the so-called elastic limit, as given in our text books and as determined by the usual methods, can be concisely defined only as the appreciable yield point, the reason upon which you base your opinion would undoubtedly interest your readers if you would kindly favor us with them. Further, that this so-called elastic limit of structural material is placed at so high a figure that it must be divided by a factor of ignorance far greater than required to cover a reasonable lack of uniformity in the material before arriving at a safe working stress, even under the most favorable conditions, would seem to indicate the importance of careful consideration of any new method of testing indicating a limit of elasticity nearer to that pointed out by general experience, and more especially so in view of the valuable observations of Wohler and Bauschinger on the peculiar manner of breaking exhibited by their test pieces subjected to repeated strains when these strains were less than the so-called elastic limit in question, as well as when they were greater.

Respectfully yours,

C. A. P. Turner.

Minneapolis, Minn., Nov. 6, 1897.

The Ringelmann Scale for Grading the Density of Smoke

Sir: I noticed the very interesting description and illustration of a method of determining the density of smoke, published in your issue of Nov. 11, 1897. It occurs to me that while the method would unquestionably serve to approximate the density of smoke emitted from a given chimney, yet it is not apparent that the plan provides a definite standard by which smoke grading in cities can be controlled, as suggested in the article. The density or blackness of smoke is dependent upon the cross section of the column of smoke emitted, as well as upon the number of soot particles to the cubic inch. Thus while the Ringelmann scale No. 2 might correspond with the color of smoke from a given chimney, it would not correspond with the color of smoke of the same actual density emitted from a larger or smaller chimney. The scales might be arranged for different diameters of chimneys, but there would still remain the different shapes of chimneys to contend with, which would necessitate choosing a particular point of observation in range with a certain diameter. After all, the test depends upon the visual judgment of the observer and it is not unreasonable to suppose that parties with a "pull" could get the inspector to see almost anything. Respectfully,

Wm. A. Rosenbaum.

Times Building, New York, Nov. 11, 1897.

(We admit the force of our correspondent's criticism, at least so far as the effect of a "pull" on the inspector's power of vision is concerned, and we do not attempt to claim that the Ringelmann smoke scale can make it possible to measure accurately what must in any possible system of measurement be estimated by the eye. It certainly seems to us, however, an improvement over methods of measurement in which density is measured only by such indefinite adjectives as "black," "dense black," "dark gray," etc.

As for the variation in the size of chimneys; perhaps it might not be so unjust as would at first sight appear to neglect this in a city ordinance. Smoke ordinances generally apply only to factory chimneys, and the owner of a large power plant might not unreasonably be held to a higher standard in the use of smokeless furnaces, careful firing, etc., than the owner of a small plant, inasmuch as neglect in the large plant will contribute much more to the pollution of a city's atmosphere. We may also point out what should have been mentioned in our original article; that probably some standard distance should be chosen from which to observe the smoke from a chimney and this distance should be varied from as little as circumstances permit.—Ed.)

Some Recent Tests of American Double Headed Steel Rails Manufactured for Export.

Sir: The Maryland Steel Co. has just finished an order of rails for India that have shown remarkably good physical tests. The specification called for a concentrated load of 28 gross tons, to be applied at the middle of the span formed by a rail seated on pin bearings 3 ft. 6 ins. apart c. to c. The load was transmitted by a round bar 2 ins. in diameter, resting on top of the rail and at a right angle with it. The application of this dead weight, which was gradual, gave a deflection of ¼-in. after a half hour's time. The rails tested were of the double-head type, and were symmetrical around the two axes passing through the center of gravity of their section.

The elements of this section were: Height of rail, 5.2 ins.; weight per yard, 75 lbs.; moment of inertia, 21.58; section modulus, 8.3. The deflection of a beam under a concentrated load at the center of the span being given by the formula,

$$\text{Deflection} = \frac{W L^3}{48 E I}$$

where W = load; L = length of span, in inches; E = modulus of elasticity; I = moment of inertia, we find in this example that E = 35,888,000 per sq. in. We also find that the bending moment in the present case was 658,560 inch pounds. The section modulus of the rail in question being 8.3, and as no permanent set was noticeable after the load had been removed, this shows the elastic limit of the material to be over 79,400 lbs. per sq. in. Some samples cut from these rails were tested for the ultimate tensile strength, and they broke at stresses slightly over 121,000 lbs. per sq. in.

These rails also behaved remarkably well under the drop test. A weight of one gross ton falling freely from heights varying between 16 and 25 ft, failing utterly to break them, though they were several times turned upside down during the test, thus reversing the stresses in the bulbs. Thirty blows were recorded, but none of the bars tested show the least sign of fracture; they are only very badly twisted. These rails, which are of Bessemer steel, have the following analysis: Carbon, 0.40; manganese, 1.02; phosphorus, 0.046; sulphur, 0.037; iron, by difference.

I cannot state the exact temperature at which these rails were finished, but it must be remembered that in all rolled steel the size of the bloom, the work put upon it, and the temperature at which it passes through the rolls, have as much to do with the strength of the finished material as its chemical composition. It is a well known fact that any kind of rolled steel finished too hot is soft and sometimes spoiled; the contrary occurs when the same material is rolled cold. Yours truly,

A. Gravelle, C. E.

Sparrows Point, Md., Nov. 5, 1897.

"Made in Germany."

Sir: A civil engineer on his travels has, it seems to me, a distinct advantage over every other kind of traveler. He sees wherever he goes the work of his brother engineers at short range, and cannot fail thus to derive an endless amount of pleasure, as well as instruction, from his trip. The conveyances he uses, the roads he travels on, the works he sees from the car windows, are largely the works of civil engineers. How much easier for him to find matters of interest as he goes along than for the poor unfortunates, who, torn out of their rut of life at home, must needs turn pseudo-artists and wear out brains and legs in the strange and novel pursuit of art, or else have nothing to do at all. Verily, the engineer sees beauty as he flies! Some of these "impressions of the voyage," as "Auguste" would say, your readers are invited to share with this American engineer on his travels.

But I begin with something I went to see. At Berlin I attended a meeting of the Prussian Ingenieur und Architekten Verein, the Prussian "Am. Soc. C. E."

Two parts only of the programme for the evening will I describe in detail. These were reports upon the results of two competitions inaugurated by the society.

This was one of them: There is at Berlin a "square," better polygon of many sides, at which come together, or cross, several tramway lines, a lot of team and omnibus and pedestrian travel, and to make the situation altogether lovely as producing intricacy and confusion, there is on this square a railway station. Its name is the Potsdamer Platz, or, as we would say, Potsdam Place or Circle. Scattered within the "circle" are places of refuge for pedestrians, which also are prominent features of the situation. Now, then, wonderful to relate, the city government not only had originally taken a prominent part in the arrangement of the tramway tracks, as well as in that of all other accessories of the Circle, but resolved, moved thereto by the results of experience, that that Circle and

its contents needed rearranging. The "society," wishing to aid in so laudable an undertaking, as well as to supply a subject of study to its younger members, offered three prizes for the three best plans of sidewalk, curbstone, and track lines and shapes and situations of refuges for pedestrians.

The evening I was there the "Committee on Potsdam Circle" reported, by its chairman, and the prizes were awarded after an analysis by the chairman of the merits and defects of each of the 19 plans that had been presented. As the authors of the several plans were then unknown to all, the plans being designated by mottos only, it was interesting to observe how freely the chairman, a typical, sterling, hew-to-the-line Russian official, managed to bring out every discoverable defect in every plan. To top off with, he hung up plan No. 20, being the plan which the city government, after having taken note of the merits and defects of the other 19, had concluded to use in this search for perfection in so humble a subject as the rearrangement of the lines and details of Potsdam Circle. May they succeed in their endeavors and "live happily ever after," will be the pious wish, I have no doubt, of all your readers.

The next competition was one called for by a manufacturer whose employees, to the number of nearly 200, use bicycles to come and go, and it may be thus formulated:

"Wanted.—A low building, occupying a minimum area, to house safely 200 bicycles, same to be stored and again removed in a minimum of time; that is, with a minimum of confusion in entering and in leaving." Possibly I may send you later a copy of the adopted best plan.

The scene shifts through a garden-like country, all "made in Germany," to the city of Cologne. Here a beautiful train-shed delights the discerning engineer. At the ends and at the sides, delicately tinted glass designs break up the only too common monotony of plain and also dirty glass in such places. If there is any place on earth where colored glass is a relief, I think it evidently is in improving upon the quarter of an acre or so of dirty glass usually to be stared at at each end of the modern train-shed.

At the ends of the tracks I noticed a hydraulic buffer, a sizable apparatus, evidently endowed with strong elastic properties, made by C. Hoppl, Berlin, 1895. I give him this "ad." free of charge or commission, and you may do the same, if you like, as a reward for having apparently solved a troublesome question in railway station operation.

We go to Bonn, and find these Germans again bridging the river they claim as their own, not as their boundary. (Overhaul your Ernst Moritz Arndt for this saying, and when found, make a note of.) The middle span is about done, and is said to have a clear span of about 620 ft. It looks it, I am sure. The river Rhine is here some 1,000 ft. wide, and this bridge will cross it with this one main span and two smaller side spans, making a most magnificent looking structure. We will build equally fine appearing bridges in the United States just as soon as our superiors will let us. Here engineers are "let." That's the difference. Yours truly,

"2 Wall St."

Bonn, Germany, Oct. 28, 1897.

The Louisville Filtration Experiments and the Philadelphia Report on Water Supply and Filtration.

Sir: In the report upon water supply and filtration to a Committee of Councils by Mr. Thomas M. Thompson, Director of Public Works of Philadelphia, several references are made to the subject of water purification at Louisville, Kentucky. While it is the distinct purpose of this Water Company to enter into no controversy concerning the best method of purification for the water supplies of other cities, yet in the above-mentioned report there are statements with reference to water purification at Louisville which are so misleading and so far from the truth that it is our duty to refute them officially in a public manner.

For the sake of clearness we shall first outline briefly the status and scope of the investigations upon the purification of the Ohio River water at Louisville. During a number of months in 1884 and in 1885, exclusive of the period of winter freshets, a series of experiments was made upon the purification of the river water after the partial removal of silt and clay by about six days of sedimentation, by slow sand filtration through filters carefully modelled after the best English types. At the conclusion of these tests the subject of water purification at Louisville was dropped for nearly ten years. It was then taken up again with the view to learning the practicability of so-called mechanical filters. A series of competitive tests of a number of the best known filters of this type was conducted from October, 1895, to August, 1896. As the final report upon these tests neared completion at the close of 1896, it was decided to amplify the investigations along this line. From January till August, 1897, further tests were made with the view to learning the relative cost and effect of different methods of securing coagulation of the minutely divided clay particles carried in the water and of the value of sedimentation so far as appliances allowed. The report upon the two years' investigations by the officer in charge has just been completed, but has not yet been acted upon by the Board of Directors. To expedite matters the Directors appointed, about two months ago, two committees to consider the best method of purification to adopt, and the financial side of the problem, respectively.

In July, 1897, a letter from Mr. Thompson was received asking about opportunities to inspect the experimental devices of this company, and the conditions concerning them. Although the tests were practically at an end, reply was made that the devices would be held in readiness for operation at the time of his proposed visit. No further word was received from him.

Instead of learning from the proper sources the general nature and scope of the investigations made by this company, Mr. Thompson makes use of statements, concerning the Louisville tests, made by Mr. F. A. W. Davis, Vice-President and Superintendent of the Indianapolis Water Co., as shown on pages 96-98 of his report. We desire to make three quotations from Mr. Davis's letter, namely:

(1) The best chemist in the city (Indianapolis) was sent to Louisville by the (Indianapolis Water) Co. during their experiments with mechanical filtration.

(2) The company also sent a chemist to Louisville to make a study of mechanical filtration. He reported to us that, in his judgment, based upon knowledge gained from actual work, that mechanical filtration was not the best method for a large city. He objected to it, first, for the great cost of the alum; second, that the quantity used was variable, and that more or less of it entered into the water which was distributed to the people for their consumption. At times, when the water was very bad, it was necessary to use as much as 14 grains of alum to the gallon to clarify it.

(3) The Louisville experiment, from recent information gained, has proven that mechanical filtration is not the best method for a large city, and that they will not adopt any of the present mechanical filters. Just what the city of Louisville will decide upon I am not advised.

Mr. Davis made a brief visit to the Louisville Water Co. on July 27, 1896, to inspect the devices undergoing tests at that time. This is the first intimation that we have received that he had a chemist at "actual work" upon the Louisville investigations. It is true that Mr. George W. Benton, Instructor in Chemistry at the Indianapolis High School, formally requested the Louisville Water Co. to allow him to work in the laboratory for one month without compensation, in order that he might become familiar with methods of bacteriological analysis. His request was granted, with the distinct understanding that he should make no public or private use of the results of the tests prior to the publication of the official report. He worked in the laboratory, accepting these conditions, from July 6 to 30, 1896. If it was from him that Mr. Davis got the information upon which his remarkable statements were based, it was done by a serious breach of professional etiquette on the part of Mr. Benton, and a distinct violation of the conditions under which the courtesy of the laboratory was extended to him.

But it is not worth while to consider further the source of information upon which Mr. Davis attempts to anticipate the official action to be taken by the Louisville Water Co. It is sufficient to say that his statements, and those accredited to his company's chemists, are incorrect; and in this public letter it is the purpose of the Louisville Water Co. officially to warn the officers in charge of municipal water departments that no credence can be given his statements, so far as they relate to investigations made at this place. Very respectfully,

Louisville Water Co.,
By Charles R. Long, President.

Louisville, Ky., Oct. 29, 1897.

(In accordance with our usual custom in such cases, we have submitted proofs of Mr. Long's letter to the persons named by him. Messrs. Thompson and Davis have sent us letters which we print below, Mr. Thompson's letter being addressed to us, and Mr. Davis's to Mr. Long. Mr. Davis also asked that his original letter to Mr. Thompson, from which Mr. Long quotes, be printed in full, and accordingly it is given below.—Ed.)

Sir: Yours of the 6th inst., enclosing proof of letter from the Louisville Water Co., taking exceptions to certain statements in my report on Filtration and Future Water Supply for the City of Philadelphia, received. I regret very much that the Louisville Water Co. should take exceptions to anything embodied in my report, as it was my effort, in preparing this report, to cast no reflections upon any special system or company. My sole desire was to procure as much light upon the subject as was available, and corresponded with a number of gentlemen whom I was informed could give me valuable data. It was in one of the letters received from Mr. F. A. W. Davis, of Indianapolis, Ind., that there appeared a statement to which the Louisville Water Co. has taken exception. There was nothing in my report.

The Louisville Water Co. has been exceedingly kind and courteous to our representatives who have visited their city, and it was my intention to make a personal visit, but was informed that their plant was not in operation and, as I did not wish to put them to the expense of starting it for my personal benefit, I did not make the visit anticipated. I was also informed that the company was not prepared to make a report, otherwise I would have delayed the transmission of my report to await the results of their experimental investigations on filtration.

Yours truly, Thomas M. Thompson,
Director of Public Works.

Philadelphia, Nov. 9, 1897.

Chas R. Long, Esq., Pres't, Louisville Water Works Co.,
Louisville, Ky.

Sir: I duly received your letter of the 30th ult. enclosing copy of a letter which you have sent forward to the Engineering News for publication. I thank you for advising me of the contents of this letter in advance of its publication, if it shall be published. Since I have been connected with the Indianapolis Water Co. I have regarded it as my duty—and in this view I am supported by the Directory of that Company—to give to public officials and other persons interested in municipal water supplies, whatever information I have gained upon such subjects, either by experience or experiments, and I believe it to be the duty of all officials occupying the position that you do to make public their knowledge and expert opinions, as to all matters connected with water-works systems.

In saying this I do not criticise the action of the Louisville Water Co.'s officers in requiring secrecy for a limited period as to the results of the filtration experiments that were made by that company in the summer of 1896. But when I wrote my letter to Mr. Thompson on August 27, 1897, I understood, and I certainly was justified in so understanding, that the period of secrecy fixed by the officers of your company had long before expired. It was stated many times in the annual meeting of the American Water-Works Association of 1896, that your company in this matter had exacted a pledge of secrecy until August, 1897. On page 123 of the printed report of that meeting, you will find just that language used by Mr. Bull, of the Jewell Filter Co.; and Mr. Hermany, speaking in behalf of the Louisville Water Co., on pp. 129 and 130 of that report, substantially corroborates Mr. Bull's statement.

Moreover, when I was in Louisville, on July 27, 1896, you assured me that your report upon these filter experiments would be published in January, 1897. Again, in January, 1897, I telegraphed Mr. Hermany for your report, and he answered that it was not yet ready, and said that "one of the causes of delay lies in the fact that we are now making further experiments, and hope to complete them before long." On August 21, 1897, I wrote Mr. Hermany for your report, and he answered that it was not yet completed, and stated that you were making still further experiments. (I was reliably informed from other sources that these "further experiments" were upon an entirely different line, namely, electrical or polarized.) But you did not in any way advise me that the period of secrecy had been extended beyond August 1, 1897. I claim, therefore, that even if I had stated to Mr. Thompson any fact that I had learned solely from the Louisville experiments of 1896, I could not be charged with a breach of confidence, and no one standing in like relation with me could be so charged.

Now, I insist that in my letter to Mr. Thompson I made statement of no such fact. I gave the opinion of the Indianapolis Water Co.'s chemist and my own opinion. Prof. Geo. W. Benton, during all of the year 1896, and for some time before and down to the present time, has been employed as a chemist by the Indianapolis Water Co. It is true that with the full knowledge of the Indianapolis Water Co., and after consultation with me about the matter, he went to Louisville in the summer of 1896 with a letter of introduction from me to your company, and that he spent the month of August, 1896, in bacteriological work in the water filtration experiments made by your company. Respecting that work, he has not yet made any report to the Indianapolis Water Co. Indeed, he has made to that company no formal report of any kind as to the filtration experiments at Louisville. His only report, thus far, was a verbal statement of his judgment and opinion of mechanical filtration from the standpoint of a large city.

As to my own opinion, expressed in my letter to Mr. Thompson, I can only say that the letter will have to speak for itself. I think that letter clearly shows that my opinion is based upon facts gathered from many sources, and that my objections to mechanical filtration for water-works in large cities are not based upon the results of the Louisville experiments entirely, or even in any large degree. I specifically refer to New Orleans and Atlanta, and speak of other investigations made by me and the directors of my company. If the Louisville experiments discredit my opinion, I think you should be willing to let the report of those experiments show wherein I am in error, and should only ask the public to withhold judgment until that report can be seasonably published, instead of exploiting your personal condemnation of my opinion when you are unwilling to state the facts which you claim to have learned from the Louisville experiments, and upon which you predicate your attack upon my opinion. Yours truly,

F. A. W. Davis, V.-P., Supt.

Indianapolis, Nov. 4, 1897.

Office of Indianapolis Water Co.,
Indianapolis, Aug. 27, 1897.

Thomas M. Thompson, Director, Department of Public Works, Philadelphia, Pa.

Dear Sir: Your favor of the 11th to hand. The directors of this water company instructed that a thorough investigation be made of all the methods known for filtering and purifying water. The writer was sent to Lawrence, Mass., the best chemist in the city was sent to Louisville by the company during their experiments with mechanical filtration. Information was sought from every possible source in this country and in Europe. After a most thorough personal examination, and obtaining the opinion of experts on water filtration, it was determined by the directors that sand filtration for a large city was the only method to be adopted. Their objection to mechanical filtration was, first, the great cost of the alum; but a more serious question is the amount of alum that shows in the water. The quantity varies with the condition of the water. That the alum does enter the water distributed to the citizens, is to our knowledge an absolute fact.

The company also sent a chemist to Louisville to make a study of mechanical filtration. He reported to us that in his judgment, based upon knowledge gained from actual work, that mechanical filtration was not the best method for a large city. He objected to it, first, for the great cost of the alum; second, that the quantity used was variable, and that more or less of it entered into the water which was distributed to the people for their consumption. At times, when the water was very bad, it was necessary to use as much as 14 grains of alum to the gallon to clarify it.

I found when visiting Atlanta that they were pumping about 3,000,000 gallons a day, and their bill for alum was nearly $14,000 a year. Their supply is the Tennessee River, and is a difficult water to clarify.

Taking the Louisville experiment and the failure at New Orleans, and the imperfect manner in which other Western River waters have been treated, we arrived at the conclusion that we would at times experience the same difficulty that others have experienced, and that the water would not be satisfactory, and it would be condemned by our Health Board. We found, further, that the alum process hardens the water quite considerably, which makes it objectionable. We further found that in water that had been filtered through mechanical filters using alum as a precipitant, when stored in a cement reservoir, a vegetable growth was made very rapidly. We were, therefore led to the conclusion that the water when filtered should be passed from the filters without delay to the consumers. Some of our directors objected seriously to the use of alum, for the reason that it might possibly affect the stomachs of infants and children, who were the largest consumers of water.

Our investigation in regard to cleaning the sand filters led us to the conclusion that mechanical devices could be adopted that would materially reduce the cost of cleaning the filter beds. At one city I visited (the works being owned by the city) I found that the wages paid the men were high, and that the hours were very short, and that the number employed to do the work was greater than they should have employed. I called the attention of the superintendent to this fact, and he stated that the works were owned by the city, and that these rates and hours were made by the city council, and that he had no control over them.

Our investigation further showed that, taking the cost of cleaning the filter beds, and everything connected with sand filtration, it was much less than the cost of alum and keeping up the machinery for mechanical filtration. No estimate was made for the cost of keeping up sand filters for the reason that there is practically no wear out to them.

The Louisville experiment, from recent information gained, has proven that mechanical filtration is not the best method for a large city, and that they will not adopt any of the present mechanical filters. Just what the city of Louisville will decide upon I am not advised.

The directors, after comparing the results from mechanical and sand filtration, decided that the results of sand filtration were much better than those obtained from mechanical filtration, and that they believed that filtration by natural methods was superior to any other method of filtration, and that the method which gave the purest and most wholesome supply should be adopted without regard to the cost, and that the company should adopt sand filtration as the best method. Yours truly,

(Signed), F. A. W. Davis, V.-P., Supt.

THE TOTAL MILES OF TELEGRAPH LINES operated by the signal corps of the army last year is given as 802. During the same period experiments were made with a combination telegraph and telephone outfit in which both instruments can be operated at the same time. This apparatus weighs about 16 lbs. complete and has been successfully tested to a distance of 600 miles.

ELECTRICALLY OPERATED TURNTABLES are being adopted in a number of yards by the Baltimore & Ohio Southwestern Ry., it having been found that the saving in time and cost of labor pays a good interest on the cost of the necessary machinery and power. A letter from the company gives the following record of experience with the use of electric power:

The general master mechanic of this company estimates that it costs 12 cts. to turn each engine by hand. Observing this expense, one of the master mechanics, about 2½ years ago, devised a plan for turning the 60-ft. turntable at Chillicothe, O., by means of an electric motor. The motor was applied to an old car wheel by cast-iron spur-gear wheels, so as to reduce the speed. The car wheel and motor were attached to a frame which was hinged to the girder of the turntable, the car wheel to run on the circular rail, or the track, of the turntable. It was found that the weight of the frame, motor and car wheel, was sufficient to give the necessary adhesion so that the tractive force would easily turn any engine. On trial, it was found that the heaviest engine could be turned completely around in 56 seconds. The current is carried to the motor by an overhead wire, which is connected directly over the center of turntable by two brass rings insulated with hard wood, so that a perfect contact is always given, thus furnishing a good conductor for the current to the motor. The current is controlled by a rheostat so the motor can be run in either direction and at such speed as may be desired. This is done by a simple lever which is moved back and forth. The cost, complete, including motor, did not exceed $500, and after 2½ years' use, the device seems just as good as when constructed, and has given such good satisfaction that it was decided to operate the turntable at Park St., Cincinnati, O., in a similar manner, except that the current is taken under ground and connection is made around the center cone of the table, so that all wiring is concealed, thus presenting a neater appearance. The electric power is purchased from the Union Depot Co. through a meter. The cost of this power for the four months of May to August, inclusive, was $29. This turntable is used on an average of 50 times each day, thus making a cost of less than ½-ct. for each time the table is turned, while, if it was operated by hand, using the figures of general master mechanic (12 cts. for each engine), it would have cost $738, which shows a saving of $709, no cost being allowed for repairs. The repairs, however, will never be very expensive. The company has just completed a plan for equipping the turntable at Shops, Ind., with a device similar to the one in use at Chillicothe, O., and will have it in operation in a few weeks. An even better showing can be made there than at Park St., Cincinnati, as more use is made of the table.

A device very similar to the one described above is in use at the West Milwaukee shops of the Chicago, Milwaukee & St. Paul Ry., and was illustrated and described in our issue of May 27, 1897.

AN ELECTRO-STATIC GROUND DETECTOR has just been placed upon the market by the General Electric Co. This style of instrument will eventually supersede the older forms using a transformer and lamp, as a static instrument is much simpler, more accurate, and is an attractive switchboard instrument. In its construction four quadrants of sheet metal are firmly fixed in position to form a cylindrical space for the accommodation of a metal vane, to which is attached the indicating needle. The design is much the same as the well-known quadrant electrometers, except that the needle swings in a vertical, rather than in a horizontal plane. The two lower quadrants are connected to the ground through a suitable binding post, while the upper ones connect respectively to binding posts on the right and left sides of the case, connected in turn to the two service lines. When no ground exists the movable vane places itself across the shortest path between the positive and negative quadrants thus bringing the needle to zero. If a ground occurs on either side three quadrants have one polarity, and only one is opposite, so that the vane must assume another position due to static attraction. The construction and connections are such that burn-outs cannot occur, and the instruments are made for pressures as high as 10,000 volts.

ANOTHER UNDERGROUND ELECTRIC RAILWAY is projected in London to connect the terminal stations of the Northwestern, Midland and Great Northern railways with the London, Brighton & South Coast terminal on the south side. The tunnel will run beneath the West End and will have a station in the Strand.

A NEW INCANDESCENT GAS LIGHT is reported by the U. S. Consul at Crefeld, Germany, as recently developed by Mr. Ernest Salzenberg, manager of the gas works of that city. The invention consists in the use of the gas at a pressure of some 3½ atmospheres. The result is a considerable increase in the luminosity of the incandescent body. A single burner of ordinary size is claimed to emit more than 1,000 c. p. The cost of a 1,500-c. p. light is stated as 4½ cts. per hour.

THE PHILADELPHIA GAS LEASE ORDINANCE, noted last week as having been rushed through the city councils, has been signed by Mayor Warwick. The execution of the lease is delayed awaiting the judgment of the courts on the legality of the lease, two suits having been brought to determine this point.

THE LAUNCH OF THE STEAMER "MIAMI," built for the Florida East Coast Co., to ply between Miami, Fla., and Nassau, New Providence Island, in the West Indies, took place on Oct. 23, at the works of the William Cramp Steamship & Engine Building Co., Philadelphia, Pa. The new vessel is claimed to be one of the finest ships for the coasting trade in the world. Her principal dimensions are:

Length on water line	240 ft.
Width on beam, molded	40 "
Depth from top deck to keel	22 "
Depth from main deck to keel	14 "
Mean draft	9½ "
Displacement	1,150 tons.
Indicated horse-power	1,600 I. HP.

The vessel is to be fitted with twin screws, which will be driven by two independent triple expansion engines, obtaining steam from four Scotch boilers. The interior fittings and conveniences for passengers will be very elaborate. The contract for the vessel was signed June 20, and the keel was laid July 3. The vessel will be completed ready for delivery before the first of next year.

THE STEAMSHIP "KAISER WILHELM DER Grosse," notwithstanding the fierce gales prevailing throughout the week on the Atlantic, made the run from Southampton to Sandy Hook in 6 days, 58 minutes. This is not up to her own record, but falls only 27 minutes short of the "St. Paul's" record trip. But, taking advantage of a moderation in the rough weather on the last day out, she made 567 knots, which is the fastest day's run on record; beating her own best time by 3 knots, and the "Lucania's" best day by 5 knots. On the full course of 3,055 knots, the "Kaiser Wilhelm" made an average of 21.1 knots. On the big day's run, the average hourly speed was 22.8 knots.

SUEZ CANAL TRAFFIC for the first six months of 1897 amounted to 4,045,239 tons, the tolls on which were $7,437,975. The total number of vessels passing through the canal was 1,458, of which 908 were British. The tonnage of the British vessels was 2,765,657 and their aggregate tolls were $5,024,957.

THREE EXAMPLES OF RECENT PRACTICE IN LOCOMOTIVE TURNTABLE CONSTRUCTION.

In our issues of April 1 and 15 we illustrated the most recent practice of ten large American railways in metal turntable construction and described briefly the experience of a number of other companies with special and manufacturers' designs for such structures. Since that time we have received a number of other designs, and three of these which differ in some important respects from the designs already shown are illustrated herewith. Perhaps the more novel of these is the hydraulic center-bearing table, which has been tested for about three years on the Chicago, Milwaukee & St. Paul Ry., and which was designed by Mr. Onward Bates, M. Am. Soc. C. E., Engineer and Superintendent of Bridges and Buildings of that company. The second table described is an example of the most recent practice on the Lehigh Valley Ry., Mr. Charles E. Webster, Chief Engineer, and the third is a pitless turntable built by the Toledo Foundry & Machine Co., of Toledo, O.

Chicago, Milwaukee & St. Paul Ry.

Table.—The main girders are 64½-ft. plate girders, 4½ ft. deep back to back of angles at the center, and 1 ft. 8 ins. deep at the ends, spaced 7 ft. apart c. to c. The top chord is horizontal and the bottom chord is parallel to it for a distance of 16 ft. at the center, and then inclines upward toward the ends. The top chord is made up of two 6 × 6½-in. angles, and two cover plates each 12 ins. wide and ½-in. thick, and 50 ft. 1 in., and 20 ft. 1 in. long, respectively. The composition of the bottom chord is the same as that of the top chord, except for the necessarily greater longitudinal dimensions due to its bent form. The web plate is ½-in. thick. There are eight angle and filler plate web stiffeners each side of the center. The main girders are braced together by two end and one center girders, six plate cross-girders, and a 4 × 4 × ⅜-ins. angle lateral system in the plane of the top chord of the plate cross-girders. This bracing is disposed symmetrically each side of the center. Fig. 1 shows a half elevation of the cross plate-girders nearest the center, the tops of which, it will be seen, come considerably below the top chords of the main girders. Riveted to the main girders are longitudinal angles in the plane of the tops of the cross plate-girders, which carry the ends of the cross ties. Between each cross plate-girder this longitudinal angle is held by two short angle brackets placed vertically. It will be seen that the notable feature about this table construction is the exceedingly rigid bracing system between the two girders. All connections are riveted with ⅞-in. rivets, and are of ample area, as will be seen from the single connection shown by Fig. 1.

Center Bearing.—The general nature of the center cross-girder which bears upon the pivot yoke is shown by Fig. 2. The hydraulic center pivot is shown by Fig. 3, and its principal parts are a base plate A, a cylinder B, a plunger C, and a yoke D. A pump is located, as shown by Fig. 3, and forces oil through the center of the plunger into the small space between the bronze and hardened steel-bearing disks, whence it passes, as the plunger ascends, the leather packing ring and the sides of the plunger to the overflow chamber at the top of the cylinder. Thus the plunger is always surrounded with oil. The pump will lift the table loaded and it is possible to turn the whole load on oil without the bottom of the plunger resting upon the phosphor bronze bearing. To prevent the table being pumped too high a cast-iron collar surrounds the cylinder and limits the height to which the plunger may be raised. In practice the plunger bears on the bottom,, and if the pressure of the oil is not enough to take all the load, a

stroke of the pump will force a film of it under the bottom.

An examination of the drawing will show other features of the pivot construction quite clearly. The Chicago, Milwaukee & St. Paul Ry. has two of these centers in use, one at Chicago and the other at Dubuque, Ia., and it is stated that it is quite easy for one man to turn the loaded table with either. It has been found that the life of the

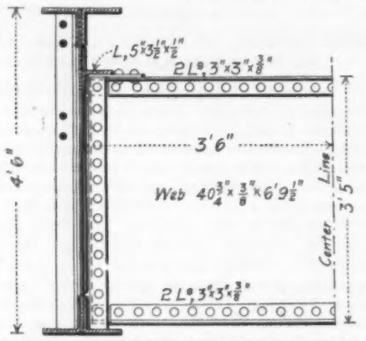


Fig. 1.—Half Sectional Elevation of Plate Cross Girder for Hydraulic Center Bearing Turntable.

leather packing is uncertain; some of the rings have given out after a few months, while others have lasted over a year. Even after the packing is worn out, however, the table turns easily owing to the perfect lubrication of the pivot. There is a hole at the base of the cylinder through which the oil can be forced out when it is foul, but it is seldom, if ever, used. To renew the leather packing the cylinder is tilted up and the plunger slipped out.

End Bearings.—Roller end bearings which travel on a circular pit track, are used with these tables. These bearings have four rollers carried by the end girders.

Ball Bearing Centers.—Besides the hydraulic center illustrated, the Chicago, Milwaukee & St. Paul Ry. has three turntables in which the centers turn on steel balls. Regarding these tables Mr. Onward Bates writes as follows:

I do not send you prints of these, because the centers were experimental, and, while they work successfully, the drawings are not in such shape that I care to have them published. Our experience with steel ball centers has led me to the following conclusions: That good results will be obtained by using plenty of balls, working in shallow grooves between top and bottom bearing plates of ordinary steel. The least friction would, of course, be when the balls roll between hardened bearing surfaces, but the load becomes so excessive on the balls that the refinement of accuracy required to distribute it among them is too great for ordinary practice. By working the balls in shallow grooves the friction is not sufficient to be objectionable, and if the balls bear against ordinary untempered steel they adjust themselves by compression of the steel so that breakage is avoided. This makes a comparatively inexpensive center, as the steel balls are commercial, and the steel rings between which they bear can easily be taken out and turned up when necessary.

Mr. Bates concludes the information which he sends us with some general remarks on turntable construction, which, as he has given the subject much study, are of particular interest. He writes as follows:

For turntables at terminal points where many engines are turned and power is available, I believe the best results will be obtained with a plain pin center and the application of power to the table. Our turntable at West Milwaukee, which is operated by an electric motor, has been illustrated in the Engineering News of May 27, 1896, and I need only to say that it gives entire satisfaction.

Commercial turntables, such as are ordinarily supplied by contractors, are built too light. A turntable should not be made to meet theoretical conditions. It will not do to say that a table is all right if it is treated right, because, as they are generally used, they are operated by whoever needs to use them, and are almost certain to get careless treatment. They will be turned when improperly balanced, and they will be stopped by throwing into gear the latch or lock while the table is in motion, giving it a heavy shock. They have to meet conditions of settlement of foundations both of the centre and of the circular balancing track.

Turntables are frequently lacking in bracing between the girders, which allows them to get in wind and to be shaky. They are also usually located where they are liable to rust, and in some instances it is found necessary to blow off steam while a locomotive is standing on the table. The result is that the whole pit, including the spaces between the girders, is filled with steam, and it is practically impossible to keep the table properly painted. In such a case I consider that it is better economy to use metal, say ½-in. thick, where ordinarily it is put in ⅜-in. thick, to meet the deterioration from rust and to lengthen the life of the table. At present prices of steel the difference in cost between a light and a heavy table is slight.

The pit is one of the most undesirable features connected with a turntable, and that objection is increased with its depth. The shallower the pit the easier it will be to drain it and to keep it free from snow. I think about nine-tenths of our tables are located where it is difficult to get drains, and in our Northwestern climate it is quite a job to shovel snow out of the pit. Some pits are so deep that if a man gets in one it is almost necessary to have a ladder to get out. You will observe in the print which I have sent you that we have endeavored to use as shallow a pit as is practicable with a deck turntable, and that the distance from base of rail on the end of the table to the top of circular rail is only 2 ft. A man can easily climb in and out of this pit. We have others where the depth is 4½ ft. A shallow pit is also less costly than a deep one, and I believe that in buying turntables the mistake is sometimes made of estimating the expenditure on the cost of the table only, instead of the combined cost of the table and pit with its foundation and retaining wall.

The objectionable pit is a strong argument in favor of through turntables in which the track is supported as near as practicable at the bottom of the girders, and I expect to see this class of table come into more general use. With whatever form of table may be adopted it is essential to have good foundations both for the center and for the circular track. The practice of laying the circular track on short cross ties tamped in ballast is bad, because this track is sure to get out of surface, especially from the effect of the frost, and the table is then screwed up at the center to enable it to turn over this unevenness in the circular track until it rocks more than it should over the center and gets undue pounding from the locomotives.

It is rare that a turntable is in such perfect adjustment that the trailing wheels at one end or the other will not have a bearing while an engine is being turned, and if the table gets in wind so as to bear at opposite corners there will be unnecessary friction in turning. It is also important that the axes of the trailing wheels at ends of girders shall be radial. We had one table which bothered us for a long time, on account of difficulty in turning it, before we discovered that ti was due to these axles not being radial.

Another important feature about a turntable is the locking device. This should be arranged so that it cannot be locked until the table is stopped. Otherwise the men who operate the table will depend on the lock or latch to stop it at the right place, which is injurious both to the table and to the rail bearings on the pit wall. In this section of the country there are a great many wooden turntables in use which will be replaced with steel when the earnings of the railways will warrant the expenditure, and although there is a small demand at this time for tables, the subject is interesting because the demand is likely to increase. The variety of designs indicate that there is no well-defined practice with regard to turntables, and the articles which you are now publishing will prove of great value to those engineers who wish to study the subject with the view of adopting a standard turntable.

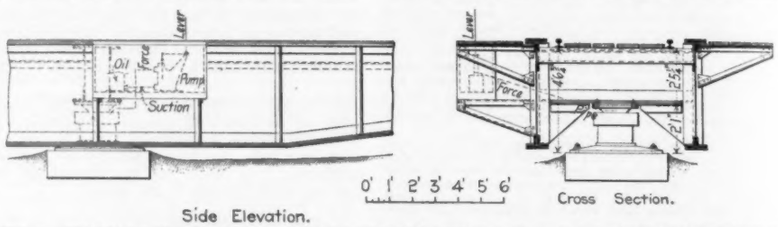


FIG. 2.—DIAGRAMS SHOWING LOCATION OF PUMP FOR HYDRAULIC CENTER-BEARING TURNTABLE.

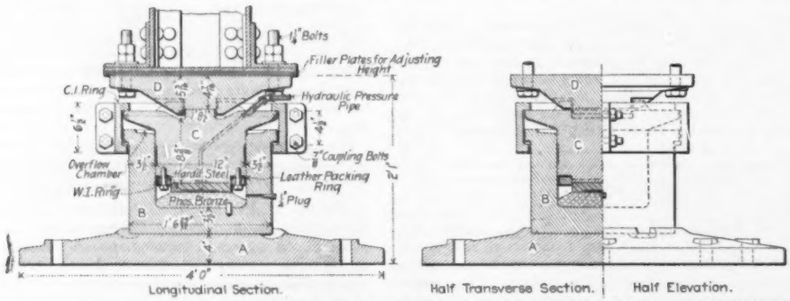


FIG. 3.—DETAILS OF HYDRAULIC CENTER PIVOT FOR CHICAGO, MILWAUKEE & ST. PAUL RY. TURNTABLE.
Onward Bates, M. Am. Soc. C. E., Designer.

Lehigh Valley R. R.

The standard length of turntable recently adopted by this company is 64 ft., and from information sent us by Mr. Charles Webster, Chief Engineer, Lehigh Valley R. R., we describe a 64-ft. 2-in. table built for the Coxton, Pa., engine house of this company. This table is calculated for a weight equal to the Lehigh Valley heavy grade engines and tender, or 125 tons, and for a cantilever load of 4,000 lbs. per lin. ft. of track.

Table.—The main girders are plate girders 4 ft. 6 ins. deep back to back of angles, at the center, and 2 ft. 2 ins. deep at the ends, spaced 5 ft. apart c. to c. of webs. The top chord is horizontal and is made up of two 6 × 4 × ⅝-ins. angles, and three cover plates each 14 ins. wide and ½-in. thick, and 23 ft. 11 ins., 44 ft., and 54 ft. long, respectively. The bottom chord bends at the center and its composition is the same as the top chord except in longitudinal dimensions. The web is ⅜-in. thick, and has six 3 × 3 × 3-16-ins. crimped angle stiffeners spaced symmetrically each side of the center. The main girders are braced together by the center and end cross-girders, two transverse 3 × 3 × 3-16-ins. angle X-frames and simple triangular top and bottom lateral system of 3 × 3 × 5-16-ins. angles, arranged symmetrically about the center.

Center Bearing.—Fig. 4 shows the general construction of the center pivot and the manner in which the center cross-girder is supported by it. This is a simple pivot bearing, the pivot of the cast-steel yoke resting directly upon a bronze disk carried in a recess at the top of the standard. To prevent the table from tipping laterally two 10-in. cast-iron wheels carried by cast-iron journal boxes fastened to the main girder webs bear against a turned cylindrical track near the base of the standard.

End Bearings.—The end bearings consist simply of two 15-in. cast-iron wheels placed radially and carried by journal boxes attached to the end cross-girder.

Toledo Foundry & Machine Co.

An important feature of this design is that it requires a very shallow pit, and, as will be seen from the drawings, it is built almost entirely of commercial shapes. The main girders are four in number and are 15-in., 75-lb. per foot, I-beams. The two outside beams are supported by top and bottom truss rods, or plates whose sizes vary with the weight of the locomotive. For the table illustrated the top truss rod is 1 × 5 ins. The main girders

are braced together transversely by S-in. I-beams to form the platform. The drawings show very clearly the spacing of the different members and their connections, and also of the center bearing,

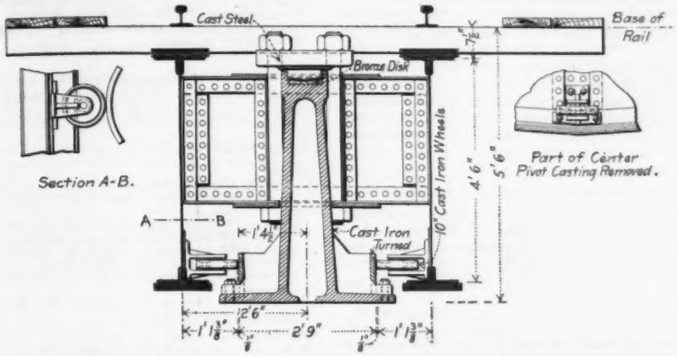


FIG. 4.—CENTER PIVOT FOR 64 FT. 2 INS. STEEL TURNTABLE FOR LEHIGH VALLEY R. R.

which, as will be noticed, is of the turntable or rim bearing type. The end bearings are also clearly shown by the drawings.

ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The fifth annual meeting of the Society was held at the house of the American Society of Mechanical Engineers in New York city, on Nov. 11 and 12. The programme consisted of twelve papers, which were read in full or by title, and discussed more or less by the members present. The business proceedings of the meeting were very brief. Twelve new members and associate members were elected to the society. The changes made in the board of officers consisted in the election of Admiral F. M. Bunce, U. S. N., as Vice-President and of Mr. W. M. MacFarland as a member of the Council.

The first paper read was entitled "Water-Tight Bulkhead Doors and the Long Arm System on the United States Steamer 'Chicago,'" by Mr. Wm. B. Cowles. A brief abstract of this paper will be given in another issue.

Regulations for Loading Vessels.

Mr. Lewis Nixon next read a paper on "Regulations for Loading Vessels," in which was described the regulations of the British Board of Trade and of the Board of Marine Underwriters' Association in America regarding the loading of vessels engaged in the ocean trade. The paper called particular attention to the discrimination made by the rules of the British Board of Trade in establishing a lower load water line in vessels clearing North American ports north of latitude 37° 30′ during the winter months than in vessels clearing from ports south of this latitude. The load water line being the line on the ship's hull below which she must not sink into the water when loaded, it will be seen that the rules of the Board of Trade allows a vessel sailing from south of latitude 37° 30′, or from say Baltimore, Md., to carry considerably more load than if she cleared from New York. The idea upon which the regulation is based is of course that for vessels sailing by the southern and less tempestous route a lower free-board, or vertical height of deck above the water line amidships, is safely allowable than if the vessel had to encounter the rougher waters and other dangers of the northern route, but in this particular instance it is claimed that the rule, while based on wise principles, is unjust for the reason that all vessels clearing from North American ports north of Cape Hatteras sail northward and take practically the same route across the Atlantic. A vessel sailing from New York, therefore, actually sails over no more stormy a route than one sailing from Baltimore, but it is compelled to carry fewer tons of freight. In respect to the regulations of the Marine Underwriters' Association in America the paper urges that, while they are very good as far as they go, the business of this Association is not so much the establishment and enforcement of rules for safe loading as it is to adjust the rates of insurance to the character of risks that the style of loading entails, and accordingly the loading of vessels is lacking in proper regulation in America in many respects. The paper urged in conclusion that some body similar to the British Board of Trade should be provided in America to have this question of the safe loading of vessels in charge.

The third paper, on "Torpedo Boat Design," by H. G. Gilmor, U. S. N., is published nearly in full in another part of this issue. It was followed by a short general paper on the "Commerce of the Great Lakes," by Mr. C. E. Wheeler. Prof. C. H. Peabody, of the Massachusetts Institute of Technology presented a paper describing the "Progressive Trials of the Boston Police Boat 'Guardian,'" in which a very full mathematical discussion of the efficiency of the boat's machinery was given, together with records of the data obtained during the trials.

Influence of Surface on Performance of Screw Propellers.

This paper described the first of an extended series of experiments on the subject mentioned in the title which the author, Prof. W. F. Durand, of Cornell University, contemplates carrying out in the future. The paper can only be briefly summarized here. The character and purpose of the experiments are quite clearly set forth in the following excerpt from the introduction of the paper:

> The investigation of propeller performance thus naturally divides itself into two fundamental parts: (1) The performance of the propeller in still or undisturbed water; (2) The modifications due to the interactions between the ship and the propeller in the actual case. In the present paper we are concerned wholly with the first subdivision, the performance of propellers in still or undisturbed water.
>
> The most extended and undoubtedly the most reliable experiments on propellers of which we have the data were those made by Mr. R. E. Froude, and reported in 1886. In these experiments, diameter, speed of advance, and area, both in amount and distribution or shape, were kept constant; the former at 0.68 ft. and the latter at a disk area ratio of about 0.36, with propellers having four elliptical blades with a maximum width of 0.4 the radius. The investigation then covered the ground involved in the variation of the other features as noted above, viz.: pitch or pitch ratio, and slip or revolutions. The investigation of the influence due to gradual variation in the area was not one of the fundamental purposes of these experiments, and the information relating to this point was restricted to the results arising from a reduction in the number of blades from 4 to 3 or 2, their shape and size remaining the same throughout. In the experiments to be hereafter described, an additional variable element—that of the amount of area—is to be introduced. In these experiments, therefore, diameter, speed of advance, and shape of blade as well as number of blades are kept constant; while amount of blade area, pitch or pitch ratio, and revolutions or slip, are subject to variation.

The paper continued with a lengthy description of the apparatus used, its calibration and the manner of keeping and computing the records obtained. In this, the first, set of experiments four-bladed propellers 1 ft. in diameter, with a pitch of 1.3 ft., area ratios varying from 0.18 to 0.72, and, maximum width of blade divided by radius, varying from 0.2 to 0.8, were tested. These propellers were attached to a frame fastened to a small steam launch and projecting ahead of the bow into undisturbed water, and were suitably connected with recording apparatus placed on the deck of the launch. The launch was run through the water over a prescribed course at varying speeds. Space permits only the most important of the results obtained by these tests to be given here. These are given by the author as follows:

> In Fig. 1 is shown the information especially sought in this series of experiments, the relation of thrust to area. We know that for a given slip there is some maximum thrust beyond which we cannot pass, no matter how much the area. This follows from the fact that, for any given element of the propeller at a given slip, there is a certain maximum acceleration of the water which cannot be exceeded, no matter how much area be employed. By making certain assumptions a value may be assigned to this, and hence a value to the maximum thrust obtainable from any given element of the propeller. By a process of approximate integration this may be summed for the entire propeller, and thus a value of the maximum thrust determined corresponding to the formation of a so-called complete column of water, or, more prop-

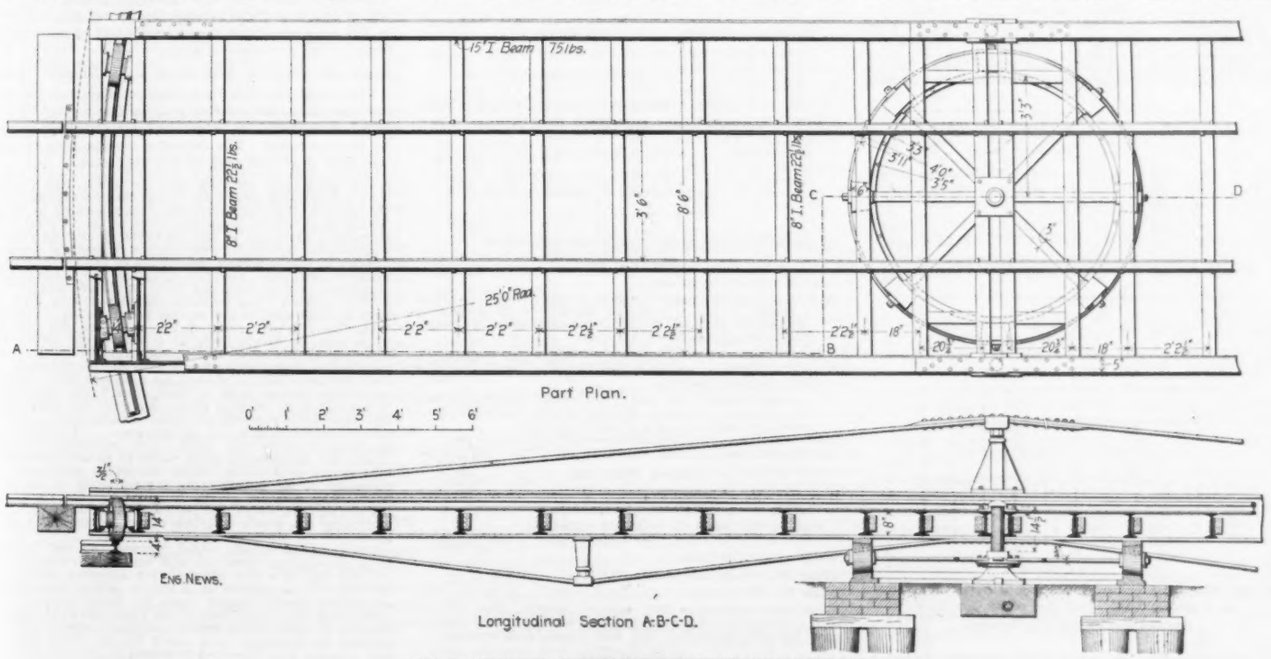


FIG. 5.—TRUSSED TURNTABLE REQUIRING SHALLOW PIT.
Toledo Foundry and Machine Co., Toledo, O., Builders.

erly, to the formation of a column completely accelerated in all parts. The influence of the back or thickness, however, is such that these results are by no means entirely reliable. Whatever the value of the maximum, however, it is evident that such a limit will

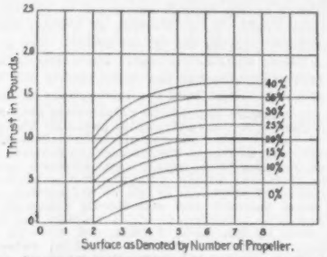


Fig. 1.—Curves Showing Thrust Developed by a Screw Propeller for Varying Surface at Constant Revolutions of 100 per Minute. Each Curve for Constant Slip as Shown.

exist, and that after the area necessary to its attainment is reached any further increase will give rise to no additional thrust, and quite possibly to a gradual decline. Passing to the other extreme, it is evident that for no area there will be no thrust. Furthermore, all experimental data on resistance lead us to expect that for very small areas the increase in thrust will be nearly proportional to the increase in area. It follows that starting with zero area the thrust will at first vary nearly with the area, but will gradually increase at a slower and slower rate with further increase, until finally a maximum is reached, after which for increase of area the thrust will either remain sensibly constant or else slowly decline. The curves of Fig. 1 are seen to be of this character. The maximum thrust for all slips is seen to be for a propeller having an area ratio of about .63. The change between numbers 6 and 8, however, is very slight, and, so far as these experiments indicate, the variation is practically inappreciable.

The general or average ratios between the thrusts of 2, 3 and 4-bladed propellers given as the result of Froude's experiments are .65, .865, and 1.00 for areas in the ratios, .50, .75, and 1.00. The corresponding ratios here found for the particular pitch ratio 1.5 with four blades and area ratios .18, .27 and .36, or with areas the same as those for 2, 3 and 4-bladed propellers, as derived from the data shown in Fig. 1, are found to vary somewhat with the slip as shown by the following table:

Slip.	Ratios of Thrusts for Area Ratios.		
	.18	.27	.36
.10	.43	.78	1.00
.15	.51	.80	1.00
.20	.56	.82	1.00
.25	.60	.83	1.00
.30	.63	.85	1.00
.35	.65	.86	1.00
.40	.66	.87	1.00

We come next to the efficiency curves of Fig. 2. These are of great interest and highly suggestive. Taking true slips within the usual working range of .20 to .30, corresponding to apparent slips of, let us say, .10 to .20, the efficiency, as we see, increases with the decrease of area,

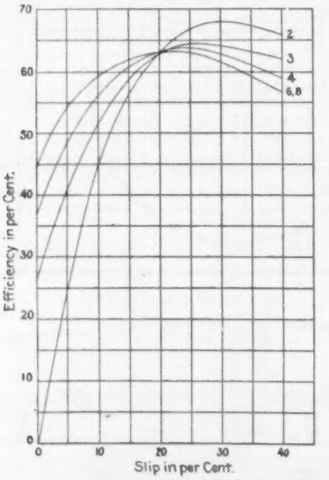


Fig. 2.—Curves Showing Efficiency of Screw Propeller for Varying Slip. Each Curve for Constant Surface as Denoted by Number.

and vice versa. For low values of the true slip, however, the reverse is the case, and efficiency increases with the increase of area. For a slip of about .20 with this pitch ratio, efficiency seems to be nearly independent of area. Or, viewed from another standpoint, a propeller of small area is comparatively inefficient at low slips, and does not reach its maximum efficiency until a high value of the slip is reached. This maximum value is, however, higher than that reached by propellers of more area. Vice versa, a propeller of large area reaches its maximum efficiency at a lower value of the slip than for less area, and such maximum is less than that for the propeller of the smaller area. Again, the variation of maximum efficiency for variation of area ratio from .18 to .72 is only about 5%, so that variation of area ratio within this range has comparatively slight influence on the efficiency.

The next paper was presented by Philip Hichborn, Chief Constructor, U. S. N., and was entitled "Notes on the Speed Trials and Experience in Commission of Our New Battleships." As this paper gives concisely the policy and ideas upon which our battleships have been designed, and in a general way presents the verdict of actual experience upon these ideas, we abstract it quite fully in another column.

A paper by Mr. Wm. P. Frear on the "Use of Water Ballast for Colliers in the Pacific Coast Trade," was next read. The author described at some length the difficulty experienced in handling colliers returning empty along the coast during rough weather owing to lack of draft, and advocated the use of water ballast as a solution of the difficulty.

Formula for Estimating Weights of Machinery.

The paper immediately following this was an unusually good example of engineering methods in collecting information and equating it into empirical formulas. It was entitled "Estimated Weights of Machinery," and was presented by Prof. Geo. R. McDermott. Its character is explained by the following quotation:

Throughout the course of many years' experience in business life, the writer has gathered together the recorded detail weights of machinery of over 300 vessels, embracing almost all of the types to be found in both the warship and mercantile fields of service. Some time ago I subjected this collection of data to a rigorous analysis with the object of arranging it in a form which would lend itself most readily to estimating purposes. Throughout these investigations, and in the arrangement of the information, certain conditions were laid down and kept clearly in view, the chief aim being to devise a system, as little complicated as possible, by which estimates of weight could be made within as short a space of time as would be consistent with the degree of accuracy required in such work; the system to be so arranged as to furnish, at the same time, the weights in such divisions as would be convenient in making trim, strength, and stability calculations of the vessels in which the machinery was to be fitted.

The following are the formulas deduced and employed by the author:

Engine-Room Weights.

D = sum of the squares of diameter (in ins.) of each cylinder directly connected to cranks.
d = sum of the squares of diameter (in ins.) of the upper cylinders of tandem engines.
L = length of stroke (in ft.).
n = number of sets of engines.

Screw propeller engines for war vessels.

Launches, pinnaces, torpedo boats, destroyers, and torpedo gunboats. } Wt. in tons = $.25n\sqrt{DL}$

Battleships, 1st, 2d, 3d class cruisers, gunboats and commerce destroyers. } [1]Wt. in tons = $.04n\,[(DL)^{\frac{2}{3}} + 375]$ [2]Wt. in tons = $.052n\,(DL)^{\frac{2}{3}}$

[1]Horizontal engines. [2]Vertical engines.

Screw propeller engines for mercantile vessels.

Launches and other small boats ..... Wt. in tons = $.27n\sqrt{DL}$

Steamers all classes, including yachts.... Wt. in tons = $.018n\,[(DL)^{\frac{2}{3}} + 390]$

Side-wheel engines for mercantile vessels.

Oscillating surface condensing ..... Wt. in tons = $.4n\sqrt{DL}$

Diagonal surface condensing ..... Wt. in tons = $.35n\sqrt{DL}$

Note.—In estimating weight of tanden engines

$$\left(DL + \frac{d}{2}\right)$$

should be substituted for (DL) in above formulas.

Shafting, Etc.

Screw propeller shafting.

D^2L = sum of [diameter^2 (inches) × length (feet)] of crank + thrust + line + propeller shafts; d^2L = sum of [diameter^2 of hole (inches) through shaft × length (feet)] of shafting.

Solid shafting ..... Wt. in tons = $.0026\,D^2L$

Hollow shafting ..... Wt. in tons = $.0026\,D^2L - .0012\,d^2L$

Paddle engine shafting.

D = mean diameter[2] of crank and paddle shafts (inches); d = diameter[2] of hole through shafts (inches); L = beam of vessel + length of one float (feet).

Solid shafting ..... Wt. in tons = $.003\,D^2L$

Hollow shafting ..... Wt. in tons = $.003\,D^2L - .0012\,d^2L$

Screw Propellers.

D = diameter of propeller (feet); S = surface of propeller (sq. ft.); n = number of propellers.

Steel or bronze with detachable blades.

	3-bladed.	4-bladed.
When value of $D\sqrt{S}$ is:		
Blw 50... Wt. in tons =	$.03n\,(D\sqrt{S}$	$.028n\,D\sqrt{S}$
Abv 50... Wt. in tons =	$.11n\,(D\sqrt{S} - 36.3)$	$.1n\,(D\sqrt{S} - 40)$

Cast-iron propellers 20% greater weight than above; steel or bronze solid propellers 25% less weight than above; cast-iron solid propellers 10% less weight than above.

Paddle-Wheels.

D = diameter of wheel to axis of floats (feet); L = length of float (feet); P = indicated horse-power; N = number of floats on one wheel; C = DLP ÷ 100N.

Feathering floats.

When value of C is:
Below 75 ..... Wt. in tons of 2 wheels = .18 C
Above 75 ..... Wt. in tons of 2 wheels = .06 C + 8.5

Note.—Weight obtained includes gear for feathering floats.

Radial floats.

When value of C is:
Below 75 ..... Wt. in tons of 2 wheels = .17 C
Above 75 ..... Wt. in tons of 2 wheels = .054 C + 8.5

Boiler-Room Weights.

D = mean diameter of Scotch and Navy (low cylindrical) types, and of the barrel of locomotive boilers (feet); L = length, over end plates, of all types (feet); S = total heating surface of 1 boiler; TS = tube heating surface of 1 boiler; N = number of boilers of each type; d = diameter of tubes (inches); l = length of tubes (feet); f = mean diameter of furnaces; n = number of furnaces in 1 boiler; π = 3.14.

$$A = \frac{HS \times d}{12\,\pi} + n\,f^2\,l,$$

$$B = \frac{HS \times d}{12\,\pi} + n\,f^2\,(L - l),$$

$$\ldots C = \frac{\quad d}{\pi}.$$

*Main boilers, etc.

Boilers:
Scotch, single ended:
Wt. in tons = $.0085N\,[D^2\,(L+2) + HS]$ — 10N.
Scotch, double ended:
Wt. in tons = $.0093N\,[D^2\,(L+2) + HS]$ — 25N.
Navy (low cylindrical), single ended:
Wt. in tons = $.0085N\,[D^2\,(L+2) + HS]$ — 8N.
Navy (low cylindrical), double ended:
Wt. in tons = $.0085N\,[D^2\,(L+2) + HS]$.
Locomotive:
Wt. in tons = $.011N\,[D^2\,(L+2) + HS]$ — 5N.

Water in main boilers.

Scotch boilers:
8 ins. abv top tubes..Wt. in tons = $.0117N\,(D^2\,L$ — 35.
Navy boilers:
6 ins. abv top tubes..Wt. in tons = $.0099N\,(D^2\,L$ — 10.
Locomotive boilers:
6 ins. abv frnc. crwn. Wt. in tons = $KN\,(D^2\,L - C$ — 125.

Values of K in formula for weight of water in locomotive boilers:

Boilers with dry bottom and	1	furnace	K =	.028
Boilers " " "	2	"	K =	.030
Boilers " wet "	1	"	K =	.032
Boilers " " "	2	"	K =	.034

Note.—Tons per inch at above levels of water = approximately .0021 DL.

Auxiliary boilers and water.

Auxiliary boiler and water (horizontal and vertical types) } ...Wt. in tons = $.031N\,D^2\,L$

* The weight of main boilers as given by formulas includes the weight of plain tubes; where Serve tubes are used an increase determined as follows:

$$\frac{HS \times 3}{2{,}240} = \text{tons increase,}$$

should be added to totals.

The next paper entitled "Navy Yard Expenses," was read by Mr. Wm. J. Baxter, Naval Constructor, U. S. N. The author drew a comparison between doing work in private ship building yards and in the government navy yards, in which it appeared that while the cost of work was the greater in the navy yards, the work was fully as good and was handled quite as rapidly. The author was disposed to think that this difference in cost could be reduced and urged the advisability of building more ships at the navy yards and keeping the plant of these yards in shape to do all classes of work.

Pneumatic Steering Gear of the U. S. Monitor "Terror."

This paper, by Mr. H. A. Spiller, described briefly the construction of the steering gear on the monitor "Terror," which is operated by compressed air cylinders controlled by electric power. The following excerpt from the paper will give a general idea of the apparatus:

The pneumatic steering gear is simple and powerful. Two athwartship cylinders, whose pistons are attached to the same heavy piston-rod, are firmly secured to castings built into the ship; the round stern of the "Terror" being peculiarly favorable to the athwartship arrangement. At mid-length, the piston-rod carries a slotted head, the brasses of which permit the sliding of the tiller as its angularity changes. The two cylinders are respectively to starboard and to port, and their outboard ends are utilized as motors. The common piston-rod is so large that only a small area is left on the inboard face of each piston. The inboard ends of the cylinders are connected by a pipe in which there is a controlling piston valve operated by the same mechanism that admits air to and exhausts it from the outboard ends of the cylinders. The distribution of air is effected by a simple slide valve receiving its motion from a "float lever," one end of which is controlled by an arm projecting from the rudder head. The float lever receives its initial motion from a threaded spindle working in a nut on the lever. The spindle can be revolved in various ways, to be mentioned hereafter. When the distributing slide valve is in mid position, so also is the controlling valve; the latter preventing any exchange of air between the inboard ends of the cylinders. Any rotation of the threaded spindle moves both the distributing valve and the controlling valve, one valve supplying the power and the other relieving the elastic lock.

The threaded spindle which operates the float lever lies in a fore-and-aft direction and carries various clutches, all but one of which engage with sprocket wheels. At the end of the spindle is a clutch which engages with an electric motor geared down by worm gearing. The wires from the motor lead to the rheostats at the steering stations in each turret and in the pilot-house. The same stations are provided with small wheels which give motion to small wire ropes led to drums in the steering-room. Each drum has its separate sprocket-chain connection to a screw spindle of the steering gear. So long as there is a supply of air, the principle of the float lever insures the motion of the tiller in obedience to that of the screw spindle.

Each steering wheel is provided with a geared index which acts as a tell-tale or indicator of the rudder's motion or, rather, of the motion which the rudder should have, as a result of the motion imparted to the screw spindle of the float lever. It is proposed to connect the tell-tale directly to the rudder post. The officer of each gun has under his feet, just above the central column, a circular index with two concentric circles, one showing the amount of rotation of the turret, the other the helm angle.